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CARDIAC ARREST DURING SURGERY

Observation and Management in Six Cases

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REVIVAL of the dead has aroused much controversial thought in modern medicine. The best definition for death is lack of life. The best definition for life is animate existence. There is a margin of safety between animate existence and lack of life. Just as nature provided us with a margin of safety in such vital functioning organs as kidney, liver and lung, she also provided us with a margin of safety between life and death. The heart may cease beating for approximately three and one-half minutes before damage to the delicate brain cells becomes irreversible. If, when cardiac arrest occurs, we can restore the heart beat within this margin of safety time limit, our patient will make an uneventful recovery.

To revert back to revival of the dead, there are many laymen as well as some of our professional colleagues who still cling to the idea that once the heart has stopped, any method directed towards restoring its rhythmic action is a dangerous and useless procedure. If there remain any disbelievers in our midst, it is my hope that some of the points to be made later will convert them so that everyone doing surgery will be watching for, prepared for, and successful in their management of cardiac arrest if such be their fate to see such a possible tragic complication.

The main purpose of this discussion is to bring again to your attention that cardiac arrest during anesthesia is really not so uncommon as one might think, and that it can happen to any of us during any type of surgical procedure, at any time—from induction

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to termination of anesthesia—and with any type of the various anesthetic agents. Once we are cognizant of the above, it should become increasingly apparent that the only successful method of effectively meeting a sudden unexpected catastrophe of this sort is to have a preconceived plan of attack and be able to put it into action without hesitation.

Once the entire operating team is prepared for the complication of cardiac arrest, most of the cases will be reanimated successfully and restored to society none the worse for their experience. However, as you have just seen, if everyone is not familiar with their duties and the time elapsed between cardiac arrest and restoration of rhythm is more than three and one-half minutes, then the victim of this complication will die either immediately or sometime in the near future. In going through the literature you see reports of patients reanimated after four minutes up to one and a half hours. Much comment could be made concerning this, but suffice it to say that probably the observations were as erroneous as wishful thinking, for it is now generally conceded that if the cardiac standstill goes beyond three and one-half minutes, permanent, irreversible brain damage results.

Not all cases of cardiac standstill during surgery can be dealt with successfully. When the heart stops because of a severely damaged cardiovascular system, or in a patient with a markedly decreased vital capacity, there is little hope, but the case that we must be ready for is the one that to all intents and purposes went onto the operating table in good physical condition.

Before proceeding with the cases at hand, I should like to give you a few historical aspects of cardiac resuscitation. The Germans started experimenting with cardiac massage in dogs in 1874. The first successful case in humans was reported by Starling and Lane in 1902 and in fact it was Lane who was given credit for establishing the procedure of subdiaphragmatic cardiac massage.

Barber and Madden in 1945 reviewed the literature and reported 143 cases with 48 (or 33 per cent) recovery. All the way through the literature we see reports of partially successful cases. This classification should be discontinued because it is nothing of which to be proud. It means those cases in which the cardiac action was reestablished, but after permanent damage had resulted to the brain cells so that death occurred in a few hours to several days later. The patient is just as dead if he dies three weeks later as he is if he dies on the table. Partially successful cases simply mean that we were not ready or did not recognize the cardiac arrest in time to get the heart started within the three and one-half minute margin of safety time limit.

Etiology: This could be discussed at great length. Undoubtedly, some hearts may stop with less provocation than others. Certain types of surgery, anesthesia, improper administration of the anesthetic agent, positioning of the patient, etc., may predispose to cardiac arrest.

However, be this as it may, there are according to my observations three factors: (1) sensitivity to the anesthetic agent, (2) vago-vagal reflex, and (3) anoxemia. These three factors will be dealt with in more detail in the ensuing case reports.

Presentation of Cases

Case 1. Female, aged 25, with pulmonary tuberculosis, who responded well to routine sanitarium treatment, but for a 2 cm. cavity in sub-apical region of the left lung. Attempt to close the cavity by pneumothorax was unsuccessful due to adhesions and closed pneumonolysis was impossible because of the broad origin of the adhesions. Thoracoplasty was refused and consequently it was decided to try extrapleural pneumonolysis. Pentothal anesthesia was administered and 15 minutes later the patient expired suddenly. Postmortem failed to reveal the cause of this death so it became evident that the death was due to an unrecognized cardiac arrest. Because it was unrecognized the patient had little benefit of resuscitation procedures other than artificial respiration which is a feeble procedure alone in cases of cardiac arrest.

Because of this unfortunate experience an effort was made to become familiar with instances of cardiac arrest and subsequently a plan for combating this complication was devised.

Case 2. Female, aged 21, being operated for gangrenous appendicitis. She was in the prime of her youth and excellent physical condition. She had been ill for only four hours. Pontocaine in glucose was administered intrathecally and the patient suffered a sharp fall in blood pressure. This apparently was responding when I clamped the meso-appendix and simultaneous respiratory and cardiac arrest occurred instantly.

Prompt artificial respiration, subdiaphragmatic massage and intracardiac injection of adrenalin resulted in restoration of both cardiac and respiratory action, but apparently the effort was not prompt enough because 21 days later the patient expired, never having regained consciousness. Postmortem findings were entirely negative except for marked degeneration of the nerve cells of the brain.

Case 3. Male, aged 27, brought in desperately wounded by a sniper's bullet which entered the left chest posterolaterally and passed diagonally through his body, ripping the left diaphragm, laying open the stomach for almost its entire length and finally coming to rest in the right lobe of the liver.

Repair was attempted transthoracically and all went well until an attempt was made to finish the closure of the defect in the pyloric area of the stomach. In order to accomplish this, rather strenuous traction was necessary to bring the defect into one's visual field. Every time traction was employed the heart would stop so that after each stitch it was necessary to institute cardiac massage in order to restore its rhythm. It was necessary to start this heart 14

times. The anesthetic was intratrocheal G.O.E. and it was necessary for the anesthetist to administer artificial respiration for over one hour during the surgery.

This is a true example of cardiac arrest due to some sort of a reflex. We call it vago-vagal for lack of a better term. Since this experience I have been informed that had I injected novocain around the celiac plexus, the arrest probably would not have occurred, or at least the troublesome nature of its recurrence could have been eliminated.

This man was very easy to manage. The chest was open, the arrest could be determined by direct vision and rhythm was easily re-established by two or three sharp manual contractions of the heart. At one time the arrest was allowed to persist for nearly two minutes to see if the heart would automatically re-establish its rhythm, but it showed no evidence of this until manually stimulated. This patient made a complete recovery.

CASE 4. Female, aged 62, being operated for an obstruction under pontocaine and glucose spinal anesthetic. Due to gangrenous degeneration of the bowel an extensive resection was in progress (72 in.) when without any warning she suddenly collapsed with simultaneous cessation of both respiration and circulation. Artificial respiration and subdiaphragmatic cardiac massage were started resulting in restoration of cardiac rhythm in a little over two minutes time.

Some twenty minutes later the same phenomena occurred and the same procedure was followed, only this time intracardiac injection of adrenalin was necessary before cardiac rhythm was re-established. The operation was concluded as rapidly as possible and the patient's condition was critical for nearly 24 hours at which time she regained consciousness. Convalescence from this point was stormy, but eventually complete, and there are no residual ill effects. The cardiac arrest in this case was quite likely due to some reflex action.

CASE 5. Female, aged 54, from a sparsely settled area of the state, for an interval appendectomy. She was given spinal anesthesia (pontocaine and glucose) and the skin sutures were being placed when collapse occurred. The abdomen was rapidly reopened and subdiaphragmatic massage instituted. The heart could be started but for only about three or four beats and then it would stop. Adrenalin was injected into the heart and the heart muscle which had been soft and mushy suddenly became extremely hard and went into fibrillary action. An intravenous was started and the patient was given 5 cc. of 5 per cent novocain in the vein. Cardiac rhythm soon became normal, but we could not re-establish respiration. Metrazol was tried and repeated. About five minutes later cardiac arrest recurred and the heart muscle again became soft and mushy. Adrenalin was repeated and again the heart began to fibrillate. This time novocain was not repeated because it began to dawn on us that perhaps we were dealing with a drug sensitivity. Approximately 45 minutes passed during which the heart fibrillated and then it began to show signs of arrest. When it became soft and flabby it would be sharply squeezed and then resume its activity for perhaps 10 or 15 beats—then it would stop again. This cycle repeated itself innumerable times when it occurred to me that perhaps some concentrated glucose would help. Fifty cc. of 50 per cent was administered I.V. with almost dramatic improvement. After some 15 minutes of normal heart action and a return to approximately normal blood pressure, it was felt safe to close the abdomen again.

However, before the skin sutures were placed, cardiac arrest again occurred and the abdomen was again opened. Cardiac massage again was performed with about the same results. Another 50 cc. of 50 per cent glucose was given with the same marked improvement. More metrazol was given and finally spontaneous respiration occurred. The patient had been under artificial respiration for one hour and forty-five minutes.

She made a complete recovery. I know this to be a sensitivity to the novocain-pontocaine group because one year later she practically died from the injection of a few minims of novocain by a dentist for a tooth extraction. Probably the only thing that saved her was the fact that the novocain had adrenalin in it and the absorption was therefore minimal.

CASE 6. Male, aged 58, subtotal gastric resection because of obstructive duodenal ulcer. Operation was proceeding satisfactorily except that the patient was breathing poorly and anesthetist started to insert an intratracheal tube when a laryngeal spasm apparently occurred. After several minutes without respiration the anesthetist called for help. I attempted to get a tube through the larynx but this was impossible. A tracheotomy was immediately decided upon and while performing this, cardiac arrest occurred. The assistant was able to get a few feeble beats by subdiaphragmatic massage and in the course of a minute or slightly more the tracheotomy was completed, and intratracheal tube inserted through the opening and artificial respiration established. As soon as the anoxemia was relieved, cardiac action returned to normal and the blood pressure which had dropped to 0/0 returned to 100/60.

This case was of particular interest because no similar ones could be found. However, a good discussion of asphyxia was found by Coryllos who divided it into four phases as follows:

1. Initial apnea during which breath is usually held either with or without spasm of the glottis.

2. Dyspnea.

3. Terminal apnea with cessation of respiratory attempts, fall of blood pressure, loss of muscle tone, dilatation of pupils and loss of sphincter control.

4. Cardiac standstill.

This is a perfect fit for this patient except he did not go through the second phase of dyspnea. Rapid restoration of an airway, cardiac massage and subsequent oxygenation saved the patient and he made an uneventful recovery.

Cases similar to this undoubtedly are very rare, but it has one real lesson. A patient can live much longer with respiratory arrest as long as the heart beats than he can when both cease simultaneously. The practical application of this is in the newborn, especially those delivered by cesarean section. Many times the cesarean baby has a good heart beat, but all efforts to establish respiration fail. The death rate in such cases is alarming, but in our group we have not had a death since we started routine intratracheal aspira-

tion in these babies. In other words, the failure to breathe was due to obstruction by mucous and fluid in the tracheo-bronchial tree and cardiac arrest finally occurs due to asphyxia. If this obstruction is relieved and artificial respiration instituted so as to protect the heart muscle from anoxemia, recovery is sure to result.

At this point it is apropos to make a few comments regarding treatment. Of prime importance is to be on the outlook for this catastrophe, next a plan of action and every member of the operating team ready to put it into operation immediately.

Mention concerning the use of adrenalin should be briefly made. In reviewing the literature it is apparent that at one time this drug was extensively used to revive many patients dying from a multitude of diseases. This, of course, has largely been discontinued now except in cardiac arrest cases supplementing massage. One can find discussions and arguments pro and con for the correct chamber of the heart to use as the recipient for the drug and whether it should be injected into the muscle directly or into the chambers.

I use a 4 in. needle and inject through the third interspace, angling medially trying to get into the right auricle.

Recently Drs. Lahey and Ruzicka advise injection into the right ventricle, approaching this through the fourth left interspace. I simply try the auricle because any heart puncture is apt to set up fibrillation and auricular fibrillation is easier to combat than ventricular fibrillation. Of course, their use of novocain with the adrenalin largely eliminates fibrillation, but there are still those individuals who are unable to tolerate novocain. The right ventricle is easier to hit than the auricle, but the main point is to have your equipment ready, know what you are going to do—then do it promptly and courageously.

Three different situations may arise which require slightly different action. These are, for convenience, divided into thoracic cases, abdominal cases, and those in which neither the chest or abdomen is open.

Thoracic cases are naturally the easiest managed because the heart is visible and readily accessible to either massage or intracardiac drug therapy. Abdominal cases are not too difficult to manage if one recognizes the cardiac arrest immediately and has an effective plan for treatment.

The last situation where neither the chest nor abdomen is opened is the one that tasks our ability and calls for immediate courageous action because our margin of safety between life and death is so narrow.

Bailey's outline, published in 1941, is, in my opinion, the best routine to follow. In the first minute the anesthetist puts in an intratracheal tube and institutes artificial respiration. The surgeon opens the upper abdomen or left chest (whichever he is prepared to do). The circulating nurse opens the previously prepared sterile supplies and the scrub nurse and surgical assistant assemble the items for use. During the second minute artificial respiration is continued and the surgeon starts cardiac massage. In the third minute adrenalin and procaine is injected into the heart by the surgical assistant. Artificial respiration and cardiac massage are continued. If we have opened the abdomen and so far haven't reanimated the heart, the surgeon now detaches the diaphragm from the left costal border with one stroke of the scalpel so that the heart can be more easily and forcefully grasped and contracted.

From this point on, in Bailey's words, one uses "massage, adrenalin, more massage and everyone has to work, work, work." "Early massage is the life-giver, adrenalin is its handmaiden."

In conclusion, I have little to add, but of this I am sure. Cardiac arrest is more common than we wish to admit and many cases have been erroneously tagged as coronaries, strokes and other syndromes such as status thymus lymphaticus. Also, the majority of these patients can be saved if every operating team is familiar with and prepared to manage the problem.

INTERNAL PIN FIXATION FOR FRACTURE OF THE CLAVICLE*

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THE clavicle is the most frequently broken bone in the body, comprising from 5 to 10 per cent of all fractures. No method of treatment satisfactory to the majority of surgeons has yet been found. This is amplified by the fact that over 200 different methods of treatment have been described.

Complete fracture of the clavicle results in shortening with overriding of the fragments; the shoulder drops downward, forward, and inward and the outer fragment goes with the shoulder. Displacement can be reduced by pulling the shoulder backward, outward, and upward, but this reduction is practically impossible to maintain in an ambulant patient due to the fact that any form of dressing which maintains anatomic reduction will be intolerable to the patient. The object of treatment is to obtain a satisfactory functional and cosmetic result while making the patient comfortable and restricting his activity as little as possible. The cosmetic and anatomical results are frequently bad, especially in women. Even in men, where the cosmetic result is not of great importance, the depressed shoulder with the shortened clavicle is not a desirable end result.

Internal pin fixation of the clavicle is not new. Many have considered open reduction of the clavicle a radical procedure and have been slow to recognize its advantages. It is seldom indicated in children, but in our hands has furnished the best method of treating the adult patient while keeping him comfortable and active, without using some form of uncomfortable, disabling dressing or plaster.

The technic is relatively simple and can be accomplished by the experienced surgeon in 30 minutes. An incision is made directly over the fracture site and the proximal end of the distal fragment is delivered through the wound with as little periosteal dissection as possible. A Steinmann pin of the desired diameter, usually 3/32 to 1/8 inches, is selected. This is drilled down the soft interior of the bone laterally, until it passes through the cortex in the posterior aspect of the clavicle near the coracoid tuberosity, and out through the skin on the posterior aspect of the shoulder. The drill is then

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transferred to the outer end of the pin, the fracture reduced, and the pin drilled back into the proximal fragment for a distance of at least two inches. When the pin crosses the fracture line, the clavicle

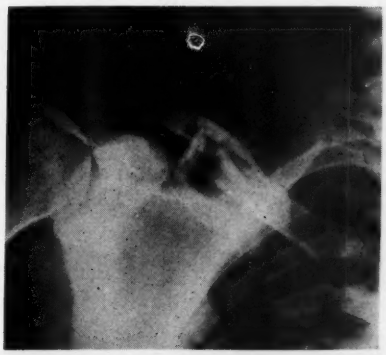

Fig. 1. Preoperative x-ray of 41 year old white male who incurred a comminuted fracture of his right clavicle in a 14 foot fall.

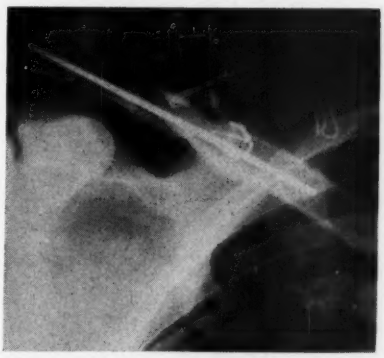

Fig. 2. X-ray taken immediately after surgery. Wire loop was used to approximate two of the larger comminuted fragments. The patient had an 80 per cent full range of motion without pain on first postoperative day and returned to his job as carpenter on the fourth postoperative day.

becomes fixed and the arm, shoulder, and clavicle can be moved freely without causing any displacement of the fragments. The distance of the pin in the proximal fragment can be determined by measuring that portion of the pin protruding laterally. The protruding portion of the pin is cut off as close as possible and the skin pulled over the cut end. A subcuticular closure of the skin is used, giving an excellent cosmetic result. No postoperative dressing except that on the wound itself is required, not even a sling.

We have found it advantageous in some cases to use strips of homogenous rib from the bone bank to cover defects in the cortex at the fracture site resulting from comminution and in cases of nonunion of old fractures. Recently, we have used pins that are threaded on the end inserted into the proximal fragment. This has served to fix the pin in the proximal fragment and to decrease the possibility of its backing out.

We have used internal pin fixation in 25 fractures of the clavicle. These occurred in 16 men and 9 women ranging in age from 16 to 70. The average age was 33. There were 21 fresh fractures which ranged from 12 hours to 14 days old. There were 3 nonunions of old fractures of the clavicle. The earliest nonunion was six weeks and the oldest two years. One malunion of a fracture one year old was pinned.

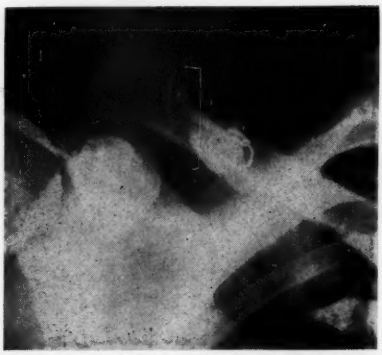

Fig. 3. X-ray taken after removal of pin at eight weeks.

The majority of these patients left the hospital on or before the third postoperative day. Many left on the first postoperative day. These people had an 80 per cent full range of motion of the shoulder without pain on the first postoperative day.

Many of those operated on were men engaged in occupations which required strenuous physical activity. Several were able to return to their jobs within five days of the injury. This has served to remove one of the larger economic barriers encountered in other, more prolonged and disabling methods of treatment.

The pins have been removed in 22 of the patients in our series. Removal was done on an average at about the tenth week, but ranged from one to four months. There was solid bony union in 21, and nonunion with recurrence of the deformity in 1. This nonunion occurred in a patient who was operated on originally for nonunion

of an old fracture. This pin was removed at the end of the third month.

The results of treatment of fractures of the clavicle with this method have been gratifying. It achieves an excellent cosmetic and anatomical result while allowing the patient to return to a relatively normal degree of activity at a very early date. It allows the wage earner to return to his occupation earlier than thought possible. The most outstanding attribute of this method, and one which most strongly recommends it, is that it furnishes a completely painless method of immobilization of the fracture during healing.

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SPONTANEOUS PERFORATION OF THE ESOPHAGUS

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ESOPHAGEAL perforation from any cause or at any level is a serious and very dangerous condition. As late as 1939 Wagner[1] was quoted as follows: "This tragic state (death from esophageal perforation) can almost never be averted by surgical intervention even if the surgery is carried out by the most skillful surgeon." The diagnosis of esophageal perforation from foreign body or some instrumentation is usually easy from history and physical examination while prompt surgical treatment plus chemotherapy has usually brought about prompt recovery.

Spontaneous rupture of the esophagus is more dramatic in its onset, is much more tragic in its outcome than the smaller perforations because of the size of the opening, the extensive contamination, shock, collapse of the lung, mediastinal emphysema and the tension pneumothorax which usually follow it. The prognosis is all the more grave because the nature of the difficulty is usually not suspected as there is little to suggest an esophageal lesion. The patient is usually in such desperate condition that adequate studies are difficult and he would appear to be unable to tolerate any surgical intervention even if recommended.

Very few physicians are familiar with the clinical picture of spontaneous rupture of the esophagus while the majority do not realize that such a condition occurs. Until the last few years, the majority of cases reported in the literature had not been diagnosed before death and in many instances not even suspected before the postmortem examination, yet the clinical picture is frequently so typical that upon two occasions the author, after he became familiar with the condition, has made the correct diagnosis over the telephone. The first description of the condition was the classical one by Boerhaave[2] published in 1724, but since that time scattered reports have occurred in literature until the total of reported cases now exceeds 60. Collective reviews have been published by Fitz in 1877,[3] McKenzie in 1884,[4] Walker in 1914,[5] Smead in 1931,[6] Girard in 1934,[7] Ridgway and Duncan in 1937,[8] Terracol and associates in 1938,[9] Barrett in March 1946,[10] Eliason and Welty in August, 1946,[11] and this author and his associates, Morse and Hertzog, in 1948[12] (a report of the 5 cases which had come under our observation up to that time). Within the last two or three years the condition has

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become better known for several additional cases have been diagnosed and a number operated upon with recovery.[10,14,17,18,19,22]

The clinical picture presented by spontaneous rupture of the esophagus may vary somewhat, but usually follows a rather characteristic line. An apparently healthy individual (84 per cent males), often very robust and a heavy eater, frequently addicted to the use of alcoholic drinks, suddenly begins to vomit (spontaneous or induced) soon after eating a large meal, and then suddenly develops a very excruciating pain usually described as epigastric or under the ribs extending through the chest on the left side to the back, followed by collapse, shock and soon by dyspnea and cyanosis. Vomiting may continue but frequentiy ceases after the onset of pain. Emphysema of the tissues at the base of the neck appears early in about 60 per cent of the patients though it may be delayed or may not occur at all. The pain is very severe, persistent and frequently does not respond even to large doses of morphine. Occasionally there is no history of a preceding large meal, the vomiting occurring because of cerebral lesion, postoperative nausea, hyperemesis gravidarum or some other lesion. Occasionally, there is no true vomiting, merely very severe and repeated retching and occasionally neither vomiting nor retching, the perforation apparently occurring as a primary condition.

The material brought up during the vomiting or a retching attempt may be food, coffee-ground material or occasionally mucus containing a small amount of blood. Rarely is there any free bleeding. A few patients present a history of previous ulcer of the duodenum or stomach (4 of the 6 cases which we have observed). An occasional patient may have a history of mild dysphagia or substernal distress suggestive of esophagitis. Other patients have presented a history of previous esophageal stricture with impaction of a bolus of food without a firm foreign body at the stricture site, the perforation occurring during a strenuous attempt to force food past the narrowed area.

When the patient is first seen, he appears to be suffering severely, is in a cold sweat and is usually sitting up or is propped up and unable to lie down. He is often weak and pale but may be cyanotic. The pulse is fast and weak, the temperature subnormal, the blood pressure frequently low while the respiration is rapid and labored. There may be emphysema of the tissues at the base of the neck (60 per cent) but this may be absent or may develop only at a later time. The upper abdomen is frequently rigid while the lower is soft and without tenderness or rebound tenderness.

Physical examination may reveal emphysema at the base of the neck evident by palpation or with a stethoscope. If the trachea is palpable, it may show deviation from the midline, particularly towards the right side depending upon the amount of left pneumothorax present. The percussion note over the left chest may be hyper-resonant or it may not. The breath sounds are likely to be distant or absent and there may be an amphoric overnote audible if the pneumothorax present is under tension. Almost invariably there is dullness to flatness at the base of the thoracic cage particularly on the left side from fluid which may be demonstrated by percussion if the patient is sitting up or by succussion splash if the patient is shaken. The heart and mediastinal structures may be displaced, the heart tones may be distant, and there may be loss of the normal substernal dullness from the tension pneumothorax.

The differential diagnosis must include perforated peptic ulcer of the duodenum or stomach, acute pancreatitis, mesenteric thrombosis, dissecting aneurysm of the aorta, coronary thrombosis, pulmonary embolism and spontaneous pneumothorax from other source. The true diagnosis is usually not made because the physician is unfamiliar with the condition, hence the possibility of such a catastrophe does not enter his mind. Meyer in 1858[18] is credited with having made the first correct clinical diagnosis of the condition. Since that time less than a quarter of the reported cases have been correctly diagnosed before death although there has been considerable improvement in the past two or three years. The last 4 of the 6 patients whom we have seen have been correctly diagnosed clinically.

The most frequent incorrect diagnosis reported in the literature has been that of ruptured peptic ulcer. Many of the reported cases have been so misdiagnosed and exploratory laparotomies carried out on nearly a quarter of the patients, including the first one in our series. Mediastinal emphysema which has occurred in almost all of these patients and which has presented in the cervical region in approximately 60 per cent cannot be produced by any of the other conditions listed in the differential diagnosis except possibly in primary spontaneous pneumothorax and is a rather rare complication of that condition. The occurrence of hydropneumothorax, unilateral or bilateral, usually on the left side which has occurred in the vast majority of the reported cases cannot be produced by any of the conditions mentioned except in primary spontaneous pneumothorax. This with the emphysema should give a strong clue to the correct diagnosis. The vomiting, pain, collapse, hydropneumothorax and emphysema should permit a correct diagnosis to be made from history and physical examination alone if the clinician is aware of the existence of such a condition.

A number of laboratory procedures may be of value in establishing or confirming a diagnosis. Among these, various x-ray examinations are probably of the greatest value. From this standpoint the earliest finding, present in all cases from the onset if recognized, is the presence of gas in the mediastinum, localized at first, later more extensive possibly involving the whole mediastinum, and eventually fanning out in the subcutaneous tissues of the neck. As long as the mediastinal pleura remains intact, the trapped gas will tend to migrate and to extend upwards but as soon as it ruptures, as it frequently does early, progression of the emphysema ceases and may even recede. The next most important finding on x-ray films is the demonstration of a fluid level low in the mediastinum. This is usually present early but frequently disappears when the mediastinal pleura ruptures and in any event is not demonstrable unless the x-ray films, particularly the lateral projection, are made with the patient in erect position.

The third important finding from the x-ray standpoint is the demonstration of a pneumothorax or a hydropneumothorax on one or both sides, more frequently on the left, the latter of course requiring that the patient be properly positioned to demonstrate the fluid level. The fourth x-ray finding of negative value in establishing the diagnosis is the absence of subphrenic air or gas indicative of perforation of a subphrenic hollow viscus. The absence of air under the diaphragm, however, does not rule out a duodenal or gastric perforation as free gas under the diaphragm is demonstrated in only 70 to 80 per cent of these lesions. If additional evidence of perforation of the esophagus is needed, a fifth procedure is available, namely, the oral administration of iodized oil or barium and demonstration of the opaque material in the mediastinum or pleural cavity adjacent to the esophagus.

The correct diagnosis may likewise be definitely established by aspiration and examination of the fluid from the pleural cavity. If it should be of a sourish odor resembling vomitus, the diagnosis is conclusively established. At times the odor of an alcoholic beverage or beer in the aspirated fluid may confirm its origin, as also may the demonstration of gastric acids or food particles in the aspirated fluid. One must be certain, however, that the exploring needle has not entered a dilated herniated stomach in the chest or mediastinum or that it has not been introduced below the diaphragm. If additional proof is necessary, the prompt appearance of some easily recognizable dye such as grape juice in the pleural cavity soon after its ingestion will definitely prove the communication between the pleural cavity and the esophagus. A negative peritoneal puncture may also be of negative diagnostic value but is usually not necessary.

If the physician has heard of the condition of spontaneous rupture of the esophagus, an accurate diagnosis may be made from the clinical history and physical examination alone and may be easily verified by suitable x-ray examinations or confirmed by aspiration of characteristic material from the pleural cavity. It is important that the diagnosis be made early and that prompt surgical intervention be undertaken for in no other way can the patient be given any but a very outside chance of recovery.

Prognosis. Any perforation of the esophagus is serious. The prognosis has now become relatively good with a small foreign body or instrumental perforation of the esophagus, under modern chemotherapy with or without surgical intervention, depending upon the size and location of the perforation. The prognosis in spontaneous perforation of the esophagus is altogether different. As late as August, 1946, Eliason and Welty[11] made the following statement: "The mortality reported so far in spontaneous rupture of the esophagus is 100 per cent excluding the 2 cases of Graham." These 2 patients of Graham's[14] had apparently already survived sufficiently long to develop a localized empyema which was drained with subsequent recovery and healing of the esophageal fistula. The size of these perforations was unstated, although the course followed would suggest that they were either small or slow perforations rather than the extensive blow-out type under consideration in this paper.

From the cases reported in the literature, 13 died under 12 hours, 24 additional patients under 24 hours, 8 under 48 hours, and only 8 survived longer than 48 hours—2 of them living 9 and 17 days each. The early deaths probably resulted from shock or unrelieved tension pneumothorax for but few of them suffered from severe hemorrhage. The later deaths apparently were from sepsis, mediastinitis or from unrelieved mechanical factors. The last few years have shown remarkable improvement in the early diagnosis and surgical management of this condition and a number of recoveries have been reported.[10,14,17,18,19,22] Undoubtedly the intensive use of antibiotics has favorably influenced this picture but in this condition the use of antibiotics without surgical intervention cannot be expected to duplicate the results which can be obtained with a small foreign body or instrumental perforation by the use of antibiotics alone.

Mechanism of Perforation. The mechanism involved in the development of spontaneous rupture of the esophagus has been described by several authors. McKenzie in 1884[4] demonstrated experimentally that the bursting pressure of the human esophagus in a cadaver varied from 5¾ to 11 pounds with an average of slightly

over 7 pounds, and that the rupture always occurred in a longitudinal direction. Zenker and von Ziemssen[15] showed experimentally that a longitudinal pull of 8½ Kg. on the average was necessary to disrupt the esophagus and that the mucous membrane was somewhat stronger than the muscular coat. Since only 2 cases of esophageal rupture in a transverse direction have been reported, this work would not seem to apply to the present problem. Duval in 1921 demonstrated that the rapidity of the introduction of air for distention of a hollow viscus was the most important factor in its rupture, more so than the total degree of pressure.

In 1931 Burt[16] showed experimentally with segments of the human intestinal tract under slow air distention that sections of the rectum withstood pressure of the greatest degree with the sigmoid, ileum, esophagus, jejunum, transverse colon, cecum, and stomach rupturing in sequence at diminishing pressures. The outer layer of the esophagus ruptured at 3.49 pounds per square inch (18.2 cm. of mercury) and the mucosa at 4.07 pounds per square inch (21.3 cm. of mercury). In 1947 at the Minneapolis General Hospital, Dr. A. Hertzog, one of my co-authors in a previous presentation on this subject, carried out a series of investigations on fresh human cadavers in which the bursting pressure of the stomach and esophagus in situ was determined by slow air distention in these structures in adults from 1½ hours to 22½ hours after death. Under the technic used, the stomach first became greatly distended, and then perforated along the lesser curvature at pressures ranging from 4 to 9 cm. of mercury (0.7660 to 1.7235 pounds per square inch at room temperature) with an average of 5.85 cm. of mercury (1.1184 pounds per square inch). Following rupture of the stomach the clamp was placed across the stomach just distal to the cardia and pressure again applied until the rupture of the esophagus occurred at pressures ranging from 10 to 33 cm. of mercury (1.915 to 6.3195 pounds per square inch) with an average of 19.27 cm. of mercury (3.69 pounds per square inch). All of the ruptures produced in this experiment occurred in a longitudinal direction in the lower third of the esophagus.

Longitudinal bursting of the esophageal wall may be related to the ease of disruption of the longitudinal muscle fibers in this area or may merely be another manifestation of the well known fact that pipes which burst usually do so in a longitudinal direction. Such bursting pressures in the human esophagus should give little comfort to those who dilate the lower esophagus and cardia with a hydrostatic or pneumatic dilator with pressures of 22 feet of water or more (48.537 cm. of mercury or 9.63 pounds per square inch), if it were not for the fact that much of this pressure is dissipated

against the rigid wall of a silk bag of the dilator rather than in stretching the esophagus or stomach beyond a certain predetermined diameter. The discussion of the distribution action of the muscle fibers in the lower esophagus and their relative contractions in rupture of the lower segment, by Lerche[20] in his recent book, are of special interest to those interested in this subject.

The question now arises as to whether pressures equal to those necessary to rupture the esophagus in the laboratory can be generated in the living human being. I am unfamiliar with any record of pressures produced in the human in the course of forceful vomiting but we do know that healthy young adults can easily blow pressures of 110 to 125 mm. of mercury (2.11 to 2.39 pounds per square inch), while an occasional well-muscled individual may blow pressures of 180 to 190 mm. of mercury (3.44 to 3.63 pounds per square inch). To what heights pressures may go under the influence of forceful spasmodic muscular contraction of forceful retching or vomiting are unknown. They certainly must exceed those produced by voluntary muscle contraction which are at least equal to the minimal pressures necessary to rupture the apparently normal esophagus at the postmortem table.

Clinically, spontaneous rupture of the esophagus must be sharply differentiated from perforations of the esophagus which follow esophagoscopy, manipulation of a foreign body, dilatation, bouginage, or passage of a tube or the rupture of an abscess of aneurysm to the esophagus, or the perforation of a carcinoma or peptic ulcer in ectopic gastric mucosa. The spontaneous perforations under consideration occur in patients who have an apparently normal esophagus or at the most, a certain degree of esophagitis in the lower esophagus, a condition which apparently is far more common than is clinically diagnosed. Traumatic rupture of the lower esophagus from application of extraneous forces has also been reported but is aside from this consideration.

Spontaneous perforation of the esophagus has occurred in the following groups of patients from the reported cases in the literature:

1. Spontaneous or induced vomiting shortly after taking a large meal.

2. Recurrent vomiting or severe continuous retching after the stomach has apparently been more or less emptied (postoperative vomiting, hyperemesis gravidarum).

3. Rupture associated with gastric retention or distention without vomiting or retching (pylorus spasm).

4. Severe vomiting in a patient with a neurogenic lesion (brain tumor—poliomyelitis).[21]

5. Forceful attempts at swallowing or retching in an attempt to dislodge impacted food by a patient with esophageal stricture.

6. Any of the above in a patient with a history suggestive of esophagitis prior to the time of rupture.

The question as to the possible influence of previous esophagitis has not been definitely settled. It is our opinion that a previously existing inflammatory reaction is not necessary for the development of this condition for it has been shown that pressures capable of rupturing the normal esophagus can be created locally. Certainly the microscopic demonstration of inflammatory reaction in an esophageal wall adjacent to a rupture of 24 to 48 hours' standing in the presence of the very virulent infection present does not prove a previously existing inflammatory process in the esophagus.

From the clinical standpoint, once an esophageal perforation is diagnosed, treatment is the same whether the rupture has occurred spontaneously, from the pressure of vomiting through a normal structure or whether there has been a previous inflammatory reaction present. Spontaneous rupture of the esophagus, however, is a blow-out through which large quantities of gastric contents and food are frequently extruded into the mediastinum and pleural cavity and presents a different clinical picture and a more serious prognosis than does the small foreign body perforation with a little seepage and gas leakage. It must be handled radically and promptly if the patient is to have any chance of survival.

Treatment. As soon as the diagnosis of spontaneous rupture of the esophagus has been made, plans should be immediately completed for prompt surgical intervention according to the following scheme:

1. Immediate treatment should be given for shock by transfusion of blood and electrolytes in an attempt to improve the patient's condition for surgical operation.

2. Immediate decompression of tension pneumothorax by needle aspiration of the pleural cavity to be followed by intercostal catheter drainage to prevent its recurrence.

3. Discontinuation of all fluids by mouth, satisfying the patient's thirst by intravenous and subcutaneous fluid administration.

4. Immediate institution of intensive chemotherapy with sodium sulfadiazine, penicillin, streptomycin and other antibiotics as indicated.

5. Immediate open posterior thoracotomy under intratracheal anesthesia with complete removal of all food and stomach contents from the pleural cavity and mediastinum, opening the latter structure as widely as is necessary to accomplish this end, followed by exposure of the ruptured area of the esophagus and its closure by interrupted sutures of silk or other suitable material in two layers if possible.

While the esophageal perforation is still open, it is wise to completely empty the stomach of all food and gastric secretions which are frequently large in amount, particularly if there is pylorus spasm present. The feeding and suction tube is then passed to the stomach, either direct or retrograde to make sure it remains empty. After the esophageal rupture has been closed, the pleural cavity is thoroughly cleaned by the profuse washing with saline possibly followed by irrigation with zepharin solution. The perforation site may be covered by a pleural flap but the mediastinal pleura must not be closed completely, and provision must be made for free drainage of this contaminated area to the pleural cavity. The local implantation of penicillin, streptomycin, and sulfonamides would appear to be justifiable though they probably do not remain long in local position because of the profuse exudation which occurs from the pleural surface.

The pleural cavity is then closed tightly, leaving several intercostal catheters in strategic locations so that following expansion of the lung and closure of the chest, continuous drainage may be made by suction to remove all fluids from the pleural cavity promptly, and to insure rapid obliteration of the pleural space. Postoperatively, continuous suction is maintained on the nasal gastric tube and nothing is permitted by mouth for several days until the perforation site has had ample opportunity to become well walled in. Supportive measures of all kinds are carried out with blood transfusions, intravenous fluids, oxygen and intensive chemotherapy. Careful watch must be kept for the appearance of fluid in the contralateral pleural cavity and early and repeated aspiration carried out if it appears. Under such a program, some, but not all, of these patients may be saved.

To date we have seen a total of 6 patients, the first 5 of which have been reported in detail elsewhere[12] and the sixth will be reported in detail in conjunction with Dr. Dean Rizer in another communication. A very brief summary of these 6 case histories follows:

CASE 1. A male, aged 73, with a history of chronic duodenal ulcer, suddenly, after eating a large dinner, was seized with very severe abdominal pain followed by the development of shock and collapse. A diagnosis of perforated

peptic ulcer was made. An exploratory laparotomy was carried out without finding evidence of ulcer perforation. The shock state continued and the patient died 30 hours after the onset of his illness. Postmortem examination revealed a rupture in the lower esophagus with secondary penetration to the left pleural cavity 7 cm. above the diaphragm. The true nature of the condition was unrecognized until the postmortem examination.

CASE 2. A 16 year old male with acute anterior poliomyelitis presented continuous severe vomiting for five days with cough and increasing dyspnea. He died in a respirator 48 hours after admission. Postmortem examination revealed a slitlike perforation in the middle third of the esophagus opening directly into the left pleural cavity which contained 500 cc. of gastric contents and blood.

CASE 3. A 70 year old man with a history of chronic duodenal ulcer was admitted to the hospital in shock with severe epigastric pain and dullness to percussion in the left lower posterior chest. X-ray films of the abdomen showed no free gas under the diaphragm. Chest films revealed mediastinal emphysema extending up to the soft tissues of the neck with a left hydropneumothorax. The diagnosis of ruptured esophagus was made by the roentgenologist from these findings. The patient was in profound shock, had a high fever and was pulseless when seen. The diagnosis of spontaneous rupture of the esophagus to the left pleural cavity was accepted and confirmed by aspiration of gastric contents from the left pleural space. The left tension pneumothorax was decompressed by an intercostal catheter thoracostomy and supportive measures administered in the hope of improving his condition to the point where surgical intervention could be undertaken. Intensive chemotherapy was administered but he never did improve to the point where we felt surgical intervention could be undertaken and he died 72 hours after the onset of his trouble. Postmortem examination revealed a linear perforation in the lower lateral portion of the esophagus extending directly to the left pleural cavity, a bilateral pleural effusion, and an obstructing duodenal ulcer with stenosis. It is our feeling now that surgical intervention should have been undertaken early in spite of his desperate physical condition. The fallacy of postponing surgical exploration in this man hoping for improvement was well emphasized by the final result.

CASE 4. A male aged 74 with a history of chronic duodenal ulcer with obstruction which had previously responded to medical management. He had vomited several times daily for two weeks prior to admission when suddenly on the day of admission to the hospital while lying quietly in bed, he was seized with a sudden very severe epigastric pain which doubled him up. There was moderate rigidity of his abdomen and the findings of a left pleural effusion with gas present. He was weak, cyanotic, dyspneic and in a state of shock upon admission. A left thoracentesis was performed and a large amount of thin brownish foul fluid removed. A left intercostal catheter thoracostomy was carried out to relieve the increasing left tension hydropneumothorax and a diagnosis of perforation of the esophagus into the left pleural cavity made. This was readily confirmed by the recovery of a small amount of swallowed grape juice by aspiration of the left pleural cavity. The patient was extremely feeble and did not improve in spite of all measures. Surgery could not be undertaken. He was removed from the hospital by the family and taken to the Mayo Clinic where he died within two hours after arrival, some 12 days following the apparent onset of his perforation.

Postmortem examination revealed a slitlike perforation in the lower esophagus directly to the left pleural cavity. He also had a localized perforating duodenal ulcer with hemorrhage and a localized peritonitis.

CASE 5. A white male aged 67 was admitted to the Minneapolis General Hospital on Feb. 19, 1946, in shock with marked dyspnea and extensive subcutaneous emphysema of the chest and neck. Shortly after noon that same day while walking down the street on his way to lunch, he suddenly developed a very severe epigastric pain, pain in the left side of his chest, and immediately collapsed. There was no vomiting. Upon admission he was in shock and suffering from marked respiratory distress. There was marked subcutaneous emphysema of the neck, left side of the chest and axilla. The trachea was deviated to the right. His blood pressure was 80/42. The left side of his chest was hyper-resonant with breath sounds absent. Chest x-ray revealed a left hydropneumothorax with subcutaneous emphysema more marked on the left. During a telephone conversation with the surgical resident, we made a diagnosis of spontaneous perforation of the esophagus and made preparations for immediate surgery. A small amount of barium given by mouth appeared promptly in the left pleural cavity confirming the diagnosis.

After adequate administration of fluids, penicillin, sulfadiazine and blood, the patient was taken to surgery where his chest was opened through a left posterior thoracotomy incision and about a quart of fluid and food removed from the left pleural cavity. The food removed was identified by relatives as material which he had eaten 24 hours previously. There was a perforation of the left posterolateral wall of the esophagus 4 cm. long just above the diaphragm communicating directly to the left pleural cavity through a larger rent in the mediastinal pleura. Through the esophageal rent, the contents of the stomach were removed, the mediastinal and pleural cavity were freed of food, thoroughly washed out and the perforation of the esophagus closed with interrupted silk sutures leaving the mediastinum open to the pleura. The pleural cavity was closed using four intercostal catheters for continuous suction. The patient tolerated the surgery exceptionally well. His blood pressure was only 60/40 at the onset of the surgery and rose to 100/60 mm. of mercury at its termination. Adequate supportive measures and intensive chemotherapy were administered postoperatively and continuous suction maintained on the intercostal catheters and the nasal suction tube into the stomach. The patient apparently was progressing rather favorably when he died suddenly of a pulmonary embolism on the ninth postoperative day.

Postmortem examination revealed the left lung well expanded with only a local suppurative pleuritis present. The process apparently was localized and we had every reason to believe that the man was recovering from this catastrophe.

CASE 6. Mr. W. S., a white male, aged 55, was admitted to Northwestern Hospital on Oct. 16, 1949, with a history and x-ray findings of an old duodenal ulcer. He was in moderate shock, rather cold and clammy, quite dyspneic and complaining of severe epigastric and lower left thoracic pain. There was no subcutaneous emphysema in the suprasternal region. He reported that at noon he had eaten an extremely large meal including wild duck, celery, corn, peas and potatoes. Soon after its completion he became quite distressed, nauseated, attempted to vomit but was unable to do so, and after several attempts developed the severe pain with which he was admitted. The trachea

was deviated to the right, there was an extensive tension pneumothorax with fluid on the left side and the abdomen was tense but not boardlike. A diagnosis of spontaneous rupture of the esophagus was made by telephone conversation with the referring physician who had already recognized the condition. Supportive measures were instituted at once and the operating room alerted for immediate surgery.

The chest was opened through a left posterior incision with resection of a wide segment of the posterior ninth rib. There was an extensive tension hydropneumothorax present with at least 1,000 cc. of liquid and solid food free in the left pleural cavity. The heart and mediastinum were markedly displaced to the right. Large masses of food recognizable as meat, celery and corn, and a large amount of gelatinous material were removed from the pleural cavity. There was a gaping necrotic area about 5 cm. long at the lower end of the left inferior pulmonary ligament somewhat hemorrhagic around the edge. The loop of the nasal suction tube which had been introduced into the esophagus in an attempt to partially empty the stomach was bulging through this rent. There was a vertical rent 2½ cm. in length on the left lateral wall of the esophagus in and just above the level of the diaphragm. Through this rent solid and liquid food contents were issuing from the stomach. There was no evidence of local bleeding. There was no evidence of mediastinal emphysema, the rupture having occurred directly from the esophagus into the pleural cavity without any burrowing in the mediastinum.

Through the esophageal rent, a large suction tube was introduced directly into the stomach and nearly 1,000 cc. of additional food and material evacuated. A No. 18 Levine suction tube was then passed in a retrograde direction through the rent in the esophagus up to the pharynx and the terminal 8 inches passed into the stomach for postoperative suction. The esophageal defect was then closed with seven interrupted mattress sutures of fine silk and the defect covered loosely with adjacent pleura leaving, however, a defect in the pleura above and below the rent for drainage of the mediastinal structures to the pleural cavity. The lower portion of the defect was reinforced with some of the adjacent muscle fibers of the diaphragm. The pleural cavity was then cleared of all foreign material, washed out thoroughly with saline and the lung expanded to the chest wall. Five intercostal suction catheters were inserted with their tips in strategic locations where accumulations might occur and 1 Gm. of streptomycin and 500,000 units of penicillin injected into the pleural cavity about the defect and the chest wall closed. The patient left the operating table in good condition with a normal blood pressure. Continuous suction was applied to the intercostal catheters as well as to the nasal suction tube, antibiotics in large doses were administered and nothing was administered by mouth, the fluid balance being maintained by intravenous and subcutaneous injections.

The postoperative convalescence was rather stormy but withal quite satisfactory. There was considerable exudation of fluid from the left pleura which drained freely through the intercostal catheters. The lung remained well expanded and no generalized empyema resulted. Fluids were withheld by mouth for eight days and when administered there was slight leakage through the esophageal defect, the fluid coming out of the suction catheters which were still in place. The intercostal catheters were removed as they became plugged, the last one to be removed being that which lay near the anastomotic site. Little leakage occurred from the esophagus when food was given by mouth after the tenth day, but a barium esophagram revealed a local bulging at the

site of rupture which persisted for about one month. Complete recovery and return to work has occurred. Medical management of his duodenal ulcer continues.

Conclusion

Spontaneous rupture of the esophagus is a rare but tragic condition whose dramatic onset and serious sequelae are exceeded only by its lethal possibilities. Its seriousness is exaggerated by the failure of physicians to recognize its true nature. It presents a characteristic clinical picture which permits accurate recognition. Prompt recognition and early radical surgical treatment may be expected to save a considerable number of these unfortunate patients.

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DOES THE REMOVAL OF THE GALLBLADDER PRODUCE FUNCTIONAL CHANGES OF THE SPHINCTER OF ODDI AND THE CHOLEDOCHUS?

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The flow and storage of bile are regulated by a series of coordinated physiologic processes involving the liver, gallbladder, bile ducts, sphincter of Oddi and the duodenum. They function as an integrated unit and not as isolated organs. Even though the gallbladder is a secular dilatation of the large bile ducts, designed specifically for the storage and concentration of bile, it requires the assistance of the sphincter of Oddi before the hepatic bile can be forced into its reservoir. The liver secretes approximately 1000 cc. of bile every 24 hours, the rate of flow varying with the nature of ingested foods. The bile is delivered into the extrahepatic ducts under a secretory pressure ranging from 50 to 150 mm. of water. When the sphincter of Oddi is relaxed, the bile by-passes the gallbladder and flows into the duodenum. During the fasting state, however, the sphincteric mechanism contracts, thereby closing the ampullary orifice of the choledochus, thus compelling the bile to enter the gallbladder. Through a process of selective absorption of water and electrolytes, the gallbladder concentrates the bile, thereby increasing its capacity for storage. When filled with the concentrated bile, the gallbladder contracts, the sphincter of Oddi relaxes, and the bile escapes through the gaping ampullary orifice into the intestinal tract. It is evident that the direction of bile flow is largely governed by the resistance offered by the sphincter of Oddi.

Problem

Does the removal of the gallbladder produce dysfunctions of the sphincter of Oddi? Proponents of the theory of reciprocal innervation have long maintained that the sphincter of Oddi becomes atonic,[1] and the common bile duct experiences a compensatory dilatation following extirpation of the gallbladder.[8] Other workers believe, that if these changes do occur, they are initiated by path-

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ologic processes, and do not result from the excision of the gallbladder. Which of these divergent beliefs shall we accept?

Presentation of Material

A. *Normal Values in Noncholecystectomized Patients*

In order to determine the pressures within the gallbladder and bile ducts, 50 patients were subjected to direct visual observations and manometric studies before performing a cholecystectomy. This was accomplished by opening the peritoneal cavity, reflecting the anterior leaf of the hepatoduodenal ligament medially, thus exposing the common hepatic and common bile ducts. Cannulae were inserted into the gallbladder and choledochus, and attached to a water manometer, so pressure values in each segment of the biliary tract could be determined.

The normal intravesicular and intraductal pressures varied between 50 to 150 mm. of water, the average being 100 mm. When the perfusing solutions were introduced into the gallbladder, they immediately passed through the patent cystic duct, and filled the common bile duct, until the pressure within the two systems were equalized. Likewise, when the solutions were injected into the common bile duct, they flowed back along the cystic duct into the gallbladder, again equalizing the pressures. It was interesting to observe that none of the perfusing fluid escaped through the ampullary outlet into the duodenum unless the intraductal pressures were increased above the normal levels at which point the resistance of the sphincter of Oddi was overcome and the choledochus emptied itself in rhythmic "gushes." These ejectional spurts occurred at regular intervals, in some patients they appeared every 3 seconds, in others every 11 seconds. Each patient seemed to have a definite time cycle for the occurrence of these periods of tonal relaxation. Strangely enough, we did not observe any muscular movements, undulations or changes in the size, shape or contour of the choledochus during any phase of ampullary activity. We feel that the bile ducts do not empty themselves by peristaltic action, but evacuate their contents into the duodenum by inducing the sphincteric mechanism to relax.

The rate with which the perfusing fluids flowed into the gallbladder did not seem to alter the point at which the sphincteric resistance was overcome. If the pressures were gradually increased, the sphincter of Oddi maintained a steady resistance until the "breaking" point was reached. If the intraductal pressures, however, were suddenly increased, the break occurred at the same tension levels. It seemed to make no difference whether the perfusion fluids were

injected directly into the gallbladders or the larger bile ducts, as far as ampullary activity was concerned. Apparently each patient has a certain sensitivity to intraductal pressures, and when the "trigger level" is reached, ductal evacuation takes place. The required pressures seldom exceeded 150 mm. of water.

As these studies were made during the course of a laparotomy, it was necessary to employ such anesthetic agents as ether, ethylene, nitrous oxide, cyclopropane, curare and spinal menstrums. A comparative analysis of the various pressure gradients failed to designate which type of anesthesia had been employed. A comparison between the operative and postoperative manometric studies, which were made on the same patients, demonstrated that the sphincteric "break" occurred at the same levels in the anesthetized and nonanesthetized groups. This compels us to believe that the anesthetic agents did not materially alter the sensitivity or function of the sphincter of Oddi, when used in concentration necessary for biliary tract operations.

B. *Effects of Cholecystectomy on the Sphincter of Oddi*

Having determined the normal pattern for intraductal pressures and sphincteric action in 50 patients with intact gallbladders, we were interested in observing the effects of removing the gallbladders in these same individuals. Using the extent of the pathologic processes as a guide we were able to segregate these patients into two groups. The first group, comprising 24 patients, had their gallbladders removed, because of stones. Cholangiographic and manometric studies, direct visual inspection and palpatory examination at the time of the primary operation failed to indicate pathologic changes within the bile ducts or their ampullary orifices. This group was considered to have no detectable alterations in duct functions. Postoperative studies were made by threading a small catheter into the cystic duct, so that its tip extended into the lumen of the common hepatic bile duct. This provided an excellent method of obtaining intraductal pressures without submitting the choledochus to surgical trauma.

In the second group, consisting of 26 patients, the pathologic processes had spread beyond the confines of the gallbladder and involved the duct system, necessitating removal of the gallbladders and exploration of the common bile ducts. The indwelling T tubes afforded a convenient method for making our physiologic studies on sphincteric action.

We found that if iodopyracet (diodrast 35 per cent) was used as the perfusing medium then both manometric determinations and

radiographic visualizations could be made simultaneously. This permitted the radiologist to describe his fluoroscopic observations, while the manometric values were being recorded by another observer. As these studies were made with diodrast, all pressure determinations have been converted into equivalents of water pressure.

Under direct fluoroscopic vision the diodrast was seen to flow down the T tube and fill the entire duct system. None of the diodrast, however, escaped into the duodenum because of the blockade established by the tonic sphincter of Oddi. When the intraductal pressures were increased above 150 mm. of water, the diodrast would escape through the ampullary orifice in intermittent gushes, indicating a break in the sphincteric tone. As soon as the main intraductal pressures fell to about 50 mm. of water, the sphincteric mechanism again regained its tonic state and the duct refilled. Cholecystectomy did not alter the sensitivity or disrupt the functions of the sphincter of Oddi, because the pressure gradients in the noncholecystectomized patients were identical with similar studies made on the same subjects following the extirpation of their gallbladders. It required just as much pressure to "break" the sphincteric resistance following cholecystectomy as it did prior to removal of the gallbladders. This fact was confirmed by performing manometric studies on 10 patients, who had had their gallbladders removed many years previously. The average lapse of time between the primary cholecystectomy and our duct explorations was 11 years, and still the sphincter of Oddi maintained normal function. Such observations eliminate the objections that it requires time for atony of the sphincter to develop after the gallbladder has been excised.

Pharmacodynamic Responses of the Sphincter of Oddi in Cholecystectomized Patients

Numerous workers have demonstrated that spasmogenic drugs, such as morphine, are capable of inducing tonic contractions of the ampullary sphincter,[1,2,3,7,9] while the spasmolytic agents, such as the nitrites, invoke a loss of tone by inducing a state of sphincteric relaxation.[7] These physiologic reactions provide an excellent method for determining the functional status of the sphincter of Oddi after cholecystectomy.

Spasmogenic Drugs

Figure 1 is a kymographic tracing showing the typical variations in intraductal pressures following the intravenous administration of 11 mg. of morphine sulfate. Note that the initial preinjection pressures average only 50 mm. of water, but within 3 minutes fol-

lowing the injection of morphine sulfate, the intraductal pressures began to increase. The maximal pressure was 250 mm. which was attained by the end of the first 7 minutes, but these high tonal tensions were maintained for only 5 minutes, and then receded to 150 mm. where it became stabilized for the next 63 minutes (fig. 1).

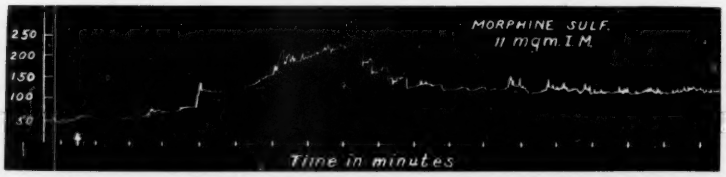

Chart 1. Pressure measured in terms of mm. of water:

Intraductal pressure taken 10 days postcholecystectomy.

Initial intraductal pressures	50
3 min. after administering 11 mg. morphine	150
7 min. after giving morphine	250
Pressures fell and were stabilized for 63 min.	140

Morphine increases the tone of the sphincter of Oddi, and increases intraductal pressure by inhibiting the free flow of bile into the duodenum.

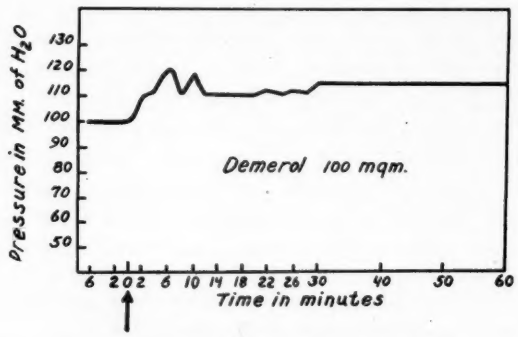

Chart 2. (8 cases.) Pressure measured in terms of mm. of water:

Demerol, 100 mg. given I.V. 8 days after cholecystectomy.

Initial preinjection pressures	100
6 min. after giving demerol	130
For next 90 min. pressures were	100

This pattern of high early rise, followed by a decline to a slightly higher level than the preinjection values have been typical of this entire study. By employing cholangiographic visualizations we were able to show that the diodrast was unable to pass through the ampullary orifice during the period of high tonal contractions. It was evident that morphine sulfate induced tonal contractions of the sphincteric mechanism to such an extent that temporary ampullary obstruction occurred.

Demerol tends to relax smooth muscles[9] but it exerts but little effect on the sphincter of Oddi when 100 mg. or less are administered. Gaenseler[4] has reported that demerol increased the pressures within the bile ducts, and with this we agree. Figure 2 represents the changes in intraductal pressures following the administration of 100 mg. of demerol intravenously. During the first 6 minutes the pressures increased from the normal of 100 mm. to 125 mm. and this increased tension was maintained for 90 minutes. Cholangiographic observations proved that the increased intraductal pressures were caused by spastic contractions of the sphincter of Oddi. Amyl nitrite was effective in overcoming the increased tonal contractions. This same pattern was obtained in the 8 patients receiving demerol.

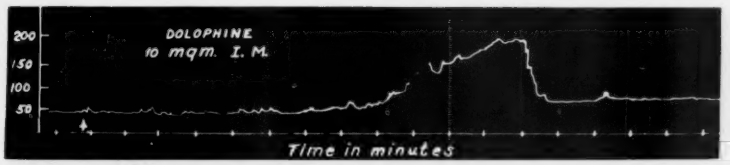

Chart 3. (8 cases.) Pressure measured in terms of mm. of water:

Dolophine, 10 mg. I.V. 8 days after cholecystectomy.	
Initial intraductal pressures	50
11 min. later	180
For next 68 min. pressures stabilized	65

Dolophine, likewise, increases the intraductal pressures as indicated in fig. 3. In several instances the pressures increased as much as 150 mm. of water, due to increased tone of the sphincteric mechanism. We have been unable to find any reports in the literature showing that dolophine possesses these properties. Codeine possesses the same spasmogenic qualities but the rise in intraductal pressures was much less marked than when morphine or dolophine were used.

Morphine-Atropine Combinations

There seems to be a general impression that a combination of morphine and atropine is much more effective in relieving biliary colic than morphine alone. This concept is predicated on the belief that atropine relaxes the sphincter of Oddi, thereby overcoming the spastic contractions of the sphincteric mechanism which is induced by morphine. In order to test the validity of this theory, a solution, containing 8 mg. of morphine sulfate and 0.8 mg. of atropine sulfate were administered intramuscularly. Prior to medication the intraductal pressures were 53 mm. of water, but within 7 minutes they had increased to 280 mm. Fluoroscopic studies indicate that

the ampullary orifice was completely closed by the resulting sphincterismus, as the diodrast could not flow into the duodenum. After this high initial rise, the pressure declined to 120 mm. where it became stabilized for the ensuing 90 minutes (fig. 4). In 7 patients we obtained higher intraductal pressures when using the combination of morphine and atropine, than when using the same dose of morphine alone. We do not believe that morphine and atropine exhibit antagonistic actions unless administered in concentrations which far exceed those employed in everyday medical practice.

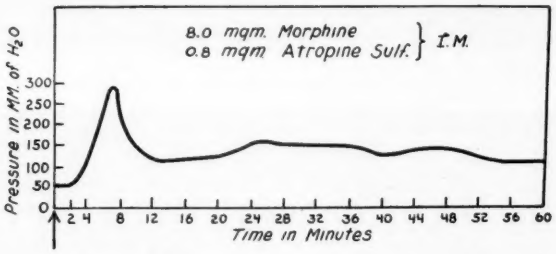

Chart 4 (8 cases.) Pressure measured in terms of mm. of water:
Morphine sulfate 8.0 mg., atropine 0.8 mg. I.M.

Initial intraductal pressures	50
7 min. later	280
12 min. later pressures stabilized at	160

Atropine sulfate 0.8 mg. does not relax the hypertonic sphincter of Oddi.

These observations indicate that the spasmogenic drugs incite the same type of tonal contractions of the sphincter of Oddi, in both the cholecystectomized and noncholecystectomized subjects.

Spasmolytic Drugs

Various studies have indicated that amyl nitrite, nitroglycerin, papaverine, aminophyllin, trasentin, and magnesium sulfate cause the sphincter of Oddi to relax. If the removal of the gallbladder results in an atonic or gaping ampullary orifice, then the spasmolytic drugs should not be able to enhance the state of sphincteric relaxation. Prior to the administration of 11 mg. of morphine sulfate intravenously, the main intraductal pressures were 80 mm., but within a period of 5 minutes they had increased to 160 mm. At this point one ampule of amyl nitrite was inhaled and almost immediately the intraductal pressures fell in precipitous manner to levels of 45 to 50 mm. Interestingly, however, the decline persisted for but 3 minutes, after which time the pressures suddenly increased to 160 mm., which was the level obtained under the influence of morphine. This same patient was given 0.6 mg. of nitroglycerin, sub-

lingually, and the intraductal pressures again fell to 50 mm., where they remained for 2 minutes, before increasing to 150 mm. Nitroglycerin, .06 mg., was injected into a T tube, so the sphincter of Oddi would be bathed by this spasmolytic agent. We were attempting to determine the influences of nitroglycerin when applied directly to the sphincteric muscles (fig. 5). The intraductal tension decreased, but the fall was less impressive than when the same dosage was administered sublingually. Apparently, nitroglycerin is absorbed more slowly from the mucosal lining of the common bile duct than from the mucous membranes of the oral cavity. Trasentin and papaverine both possess spasmolytic properties and reduce the intraductal pressures, but the responses are much less dramatic than those induced by the nitrite group.

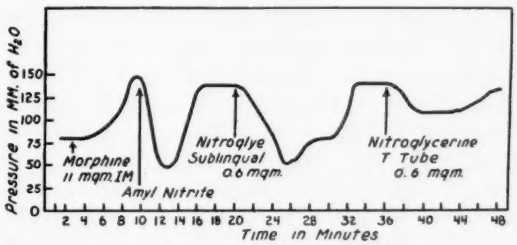

Chart 5. (8 cases.) Pressure measured in terms of mm. of water:

Morphine sulfate 11 mg. administered I.V.	
Initial intraductal pressures	75
Highest intraductal pressure	150
Nitroglycerin 0.6 mg. sublingually to above patient.	
Pressure at time of giving nitroglycerin	150
2 min. later pressure fell to	50
6 min. later pressure increased to	140
Nitroglycerin injected into T tube 0.6 mg.	
Preinjection pressure, morphine influence	148
2 min. later	125
4 min. later	140

Nitroglycerin produces a complete relaxation of the sphincter of Oddi, even when stimulated by morphine. The relaxation phase is very short, about 2 min., then the pressure increased to the morphine levels.

Local Anesthetic Agents

Harris and Marcus[8] reported that if nupercaine could be applied directly to the sphincter of Oddi, its topical action would induce a complete sphincteric relaxation, permitting one to lavage intraductal stones through the gaping ampullary orifice. We were unable to confirm these conclusions. A solution of nupercain, 10 cc. of 1-500 mixture, was introduced into the T tubes of 7 patients, and we were unable to observe any changes in intraductal pressures. Cholangiographic visualizations, likewise, failed to show any relaxation of the

sphincteric mechanism. Similar investigations were carried on with pontocaine, 2 cc. of 2 per cent solution, without significant changes being noted. We do not feel that the topical application of local anesthetic agents to the sphincter of Oddi will result in a state of sphincteric relaxation or ablation of sphincter tone.

It is evident that the spasmolytic drugs produce the same states of sphincteric relaxation in the cholecystectomized patients as were observed in those having intact gallbladders. We are compelled to believe that removal of the gallbladder does not result in atony of the sphincter of Oddi.

Discussion

The clinical application of these studies is very important. The removal of the gallbladder does not produce a compensatory enlargement of the common bile duct. None of the 1700 cholangiograms which we have taken have demonstrated any evidence of choledochal dilatation as a result of excising the gallbladder. The patients in whom dilated ducts have been encountered we have been able to demonstrate that some intraductal obstructions, such as stones, tumors, strictures, or a compressive pancreatitis, have been present. When the surgeon, therefore, encounters enlargement of the bile ducts, some pathologic condition is present to provoke these changes. If therapy is to be successful, the provocative factors must be corrected.

These studies shed some light on the manner in which cholecystopathies produce biliary pains. It is frequently stated that pain is the result of distention of the larger bile duct, but we are convinced that alterations in the hydrodynamics of the biliary system play a minor role in the pathogenicity of pain. In none of our patients were we able to produce painful responses by distention of the common bile ducts unless the intraductal pressures exceeded 400 mm. of water. This intraductal tension is much higher than that which is encountered in an obstructed biliary system. Ivy[6] states that the maximum secretory pressure of the liver is approximately 300 mm. of water, and it is difficult to understand how the intraductal pressures could ever exceed this value. We believe that the inflammatory reactions, incident to infection and chemical irritation, which accompany most cholecystopathies, invoke a hypersensitivity of the regional nerve plexuses, thereby permitting lower pressures to incite the pain reflex.

How shall we control the pain of biliary colic? If pain is not the result of increased intraductal pressures, then spasmolytic drugs should be ineffective in relieving such distress. Such have been our

experiences. The evanescent action of these antispasmodic drugs, likewise, makes them very ineffective as therapeutic agents for the relief of biliary colic. The spasmogenic drugs, such as morphine, afford respite from the distress of an obstructed biliary system. Although morphine enhances the tonal contractions of the sphincteric mechanism, the increased intraductal pressures are still below the pain levels, and the depressing action of these drugs on the central nervous system counteract any untoward effects which might come from the increased tension within the ducts.

Summary

1. Cholangiographic and manometric studies on 50 noncholecystectomized patients indicate that the pressure within the extrahepatic biliary system is governed by the secretory pressure of the liver and the resistance offered by the sphincter of Oddi. When the sphincter contracts, the ampullary orifice of the common bile duct is closed and the choledochal bile is forced into the lumen of the gallbladder. Evacuation of bile occurs when the sphincter of Oddi relaxes and the gallbladder contracts. The phase of sphincteric relaxation occurs at regular intervals and permits the bile to escape into the duodenum in rhythmic spurts. The common hepatic and common bile ducts did not exhibit any evidence of peristaltic action during ampullary activity.

2. Anesthetic agents, such as ether, ethylene, nitrous oxide, cyclopropane, curare, and spinal anesthetic mixtures, do not produce atony or relaxation of the sphincter of Oddi when used in concentrations employed for surgery.

3. Removal of the gallbladder does not produce atony or paralysis of the sphincter of Oddi.

4. The common bile duct does not undergo a compensatory enlargement following removal of the gallbladder. An analysis of 1700 cholangiograms, done on cholecystectomized patients, failed to show any dilatation of the bile ducts unless some organic ductal obstruction was present.

5. Cholangiographic visualizations and manometric studies indicate that the spasmogenic drugs, such as morphine sulfate, demerol, dolophine, and codeine sulfate, increase the tonal contractions of the sphincter of Oddi. Identical responses were obtained in both the noncholecystectomized and cholecystectomized patients.

6. The spasmolytic drugs, such as nitrites, aminophyllin, trasentin, and papaverine, all cause the sphincter of Oddi to relax. The effects are very fleeting, as the intraductal pressures returned to

normal within 3 minutes after administering the nitrites, and 20 minutes after giving the aminophyllin.

7. Organic obstructions of the bile ducts do not produce pain by increasing the intraductal pressures since manometric studies showed the intraductal tensions to be practically normal. We believe that inflammatory processes, incident to infection and chemical irritation, produce a hypersensitivity of the local and regional nerve plexuses, so that painful reflexes are initiated by normal or only slightly elevated intraductal pressures.

8. Spasmogenic drugs, such as morphine sulfate, are more effective in relieving the pains of biliary colic than are the spasmolytic agents, typified by the nitrites.

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THE OCCURRENCE OF MASSIVE GENERALIZED WOUND BLEEDING DURING OPERATION

With Reference to the Possible Role of Blood Transfusions in Its Etiology

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MOST surgeons performing major operative procedures have experienced sudden and immediately severe loss of blood in the patient on the operating table. In most instances, fortunately, this spectacular episode is mechanically controllable almost automatically by the experienced operator. But to have as one's responsibility a patient who, while on the operating table, loses blood in the form of a massive generalized "ooze" from all cut surfaces of the operative wound resulting in uncontrollable exsanguination and death is indeed a regrettable, if not a terrifying, experience. Such catastrophic circumstances have occurred. The bleeding begins insidiously, usually during or immediately after operation, and culminates in a state refractory to virtually all known methods of hemostasis—mechanical, chemical and theoretical. Of 7 cases which are briefly described here, 2 were fortunately salvaged from a fatal outcome only because of the fact that the surgical wounds, superficially situated in these patients, allowed themselves to prompt and complete mechanical hemostasis by open packing. In addition to the rote accounting of these cases, it is desirable to analyze the data associated with these patients so that logical explanations of the bleeding may be attempted. The evidence tends to incriminate whole blood transfusion reactions of the hemolytic type. This report may be justified, then, as a warning against the indiscriminate use of blood transfusions in an era when whole blood infusions are employed almost promiscuously. Certainly the gross methods of typing and cross matching of banked blood ordinarily used in the hospitals of today do not detect incompatibility among all subgroups

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of blood types. Furthermore, it is well known that the rather common transfusion reactions, manifested by fever, chills and urticaria, occur in spite of the so-called accurate cross matching of the infused blood with the recipient. More severe complications of blood transfusions such as the anuria of the "transfusion kidney" also follow the injection of supposedly "compatible" blood. Intravascular hemolysis of varying degrees is apparently a common manifestation of the hemolytic type of transfusion reaction.

Of the many and various reactions and complications of blood transfusions described in the literature, the occurrence of hemorrhage and exsanguination following transfusion is not well documented. Wiener,[1] while discussing the hemolytic type of reactions in his book, "Blood Groups and Transfusions," briefly states: "Not infrequently a hemorrhagic tendency develops immediately after the transfusion and blood may ooze from the site of transfusion, from the gums, uterus (in postpartum cases), or any fresh puncture made in the skin for the purpose of treatment." He also refers to confirmatory findings at autopsy.

Postmortem evidence that a hemorrhagic phenomenon may occur following the infusion of incompatible blood is given by Lattes in 1932.[2] He refers to the small hemorrhages or emboli in the brain, mesentery, endocardium and gastrointestinal tract which are frequently found at autopsy. Lindau[3] has described severe hemorrhagic and ulcerative changes in the colon which would account for the occasional occurrence of bloody diarrhea in patients suffering from hemolytic reactions. In other organs, pinpoint hemorrhages in the serous membranes and in the kidneys and liver have been noted.

Isolated clinical case reports exemplifying bleeding as a complication of transfusion reactions are available. Astrowe[4] reports a case of a baby 18 months old who was transfused with no reaction with 180 cc. of blood from the mother previous to a mastoid operation. The transfusion was repeated in 20 days without regrouping the mother. The baby developed vomiting, cyanosis, coma and hemoglobinuria. There developed bleeding from the mastoid incision and from the mucous membranes of the mouth. This patient gradually recovered. A retest of the mother and child was done and the bloods were found to be incompatible. Levine and Segall[5] report a reaction following the use of a donor for the second time in the same patient without regrouping. Five hundred cc. of blood were given. This was followed by a severe chill and temperature of 105 F. There was cyanosis, dyspnea and a weak pulse. The patient vomited a bloodstained mucus and complained of severe pain in the lumbar region. There was blood oozing from the mucous mem-

branes of the mouth and gums. Seven hours later the patient vomited a dull red fluid and clotted blood. There was hemorrhage from the rectum and vagina and a bloody urine. These symptoms continued for five days, suddenly ceased, and the patient recovered. Parr and Krischner[6] report a case of an incomplete abortion with a severe secondary anemia when given a direct transfusion. Following the injection of 200 cc. of blood the patient developed vertigo, nausea, which progressed to dyspnea, edema of arms and legs, weak pulse and cyanosis. One and one-half hours after transfusion the patient began to bleed from the prick of the transfusion needle. She vomited a bloodstained mucus; there was dark venous bleeding from the vagina and bloody urine. Death occurred four and one-half hours after transfusion from circulatory failure. Abramson[7] adds a fourth case of a hemolytic transfusion reaction with death due to exsanguination. This case was that of a white female aged 24, gravida II, para I, who was admitted to the hospital near the termination of a normal pregnancy because of a severe anemia. An indirect citrate transfusion was begun, using the husband as a donor. There was no agglutination or cross grouping. A reaction immediately occurred consisting of a heavy feeling in the chest, dyspnea, nausea, emesis of a bloodstained mucus, and frequent loose black stools. There developed, in addition, a moderate amount of vaginal bleeding, and bleeding from the gums and roof of the mouth. It was also noted that there was bleeding from a prick in the ear which had been made the day before for a sample of blood. A stillborn female infant was born followed by a bloody hemorrhage despite pituitrin, uterine massage, and finally a tight uterovaginal pack. In spite of various restorative measures applied, the patient expired. The blood that was collected in this case, as a result of this massive hemorrhage, showed no evidence of clotting after three hours. Brief reference is made to an additional case by DeGowin, Hardin and Alsever[8] who describe a hemolytic reaction in a patient who received a transfusion of blood of homologous group A. There occurred an increase in the vaginal bleeding for which the patient had entered the hospital, as well as the usual manifestations of a reaction of a hemolytic type. It should be noted that in the cases previously reported, in which there was exhibited a hemorrhagic tendency during reactions to infused blood, all were of the hemolytic type of reaction. Moreover, the hemolytic reactions occurred subsequent to the use of blood of homologous groups. The obvious nondetectable incompatibility was therefore postulated as due to subgroup differences.

The hemolysis present in infants with erythroblastosis is ostensibly accountable to sensitiveness to, or immunization by, differences

in Rh subgroupings. The hemorrhages which occasionally occur in the hemolytic type of erythroblastosis fetalis have not been satisfactorily explained. Potter[9] describes occasional alterations in the bleeding and coagulation times, as well as a reduction in the circulating platelets. She states that platelet deficiency may contribute to the hemorrhagic manifestations which occasionally exist in these patients. Vitamin K, although used, is said to be of doubtful value.

If hemolytic transfusion reactions manifested occasionally by hemorrhagic tendencies are, in reality, anaphylactic responses representing antigen-antibody reactions in either homologous or heterologous groupings, one might expect to find corollary examples of similar syndromes among anaphylactic reactions of other types. Such references to altered coagulability of the blood during anaphylactic and peptone shock are numerous and well known. As early as 1880, Schmidt-Mülheim[10] had noted the increase in the clotting time of the blood which followed an intravenous injection of Witte peptone into dogs. In 1909 Biedl and Arthus,[11] independently, reported a marked increase in the clotting time of the blood of dogs in anaphylactic shock. The responsible anticoagulant was early suggested by Howell[12] to be heparin. Quick's[13] investigations supported Howell's contention that the substance liberated in peptone shock counteracted the clotting effect of concentrated solutions of thrombin. This antithrombin factor was identified by Waters, Markowitz and Jaques[14] with heparin on the basis of the fact that protamine which neutralizes the anticoagulant effect of heparin[15] also restores blood coagulability in peptone and anaphylactic shock. Jaques[16] later isolated heparin in a cystalline condition from the blood of dogs in anaphylactic shock which, moreover, is not found in the blood of sensitized hepatectomized dogs in anaphylactic shock. The coagulation defect occurring in peptone and anaphylactic shock was reported by Silva, et al[17] to include a factor of fibrinolysis as well as the discharged heparin. Furthermore, a sudden and severe decrease in the circulating platelets occurs in both peptone and anaphylactic shock, as shown by Quick, Ota and Baronofsky.[18] They found that splenectomy has no effect on the thrombopenia of peptone shock in dogs. They also discussed the possible relationship of the thrombopenia of shock of thrombocytopenic purpura. The role of allergy in the pathogenesis of purpura and thrombocytopenia is discussed by Madison.[19] Allen, et al,[20] have called attention to the thrombopenic and hemorrhagic tendency following irradiation by x-ray and radioactive substances. An antithrombin, presumably

heparin, was found in the blood which responded favorably to treatment with toluidine blue dye.

In an attempt to reproduce in the dog the bleeding syndrome seen in human beings, Nelson, et al[21] have reported the production of a hemorrhagic state in dogs by the infusion of hemolyzed blood. They suggest that hemolysis does not appear to be the only factor in operation. It has been found by others[22] that hemolyzed blood per se, will produce hemolytic reactions in dogs which lack the hemorrhagic features as seen in the patients here reported. However, repeated transfusions of pooled whole blood in purebred dogs have been shown to produce bleeding on a basis of heparinemia.

No real evidence has been found as to the nature of the coagulation defect or bleeding tendency occasionally observed in patients suffering hemolytic types of transfusion reactions.

Case Reports

Case 1. P. B., a 72 year old male, blood group O Rh pos., entered the University of Minnesota Hospitals with a diagnosis of carcinoma of the stomach. After preoperative preparation with several blood transfusions, with occasional mild reactions, he was subjected to exploratory laparotomy under anesthesia consisting of Baird's solution* which was later switched to cyclopropane and ether. Extensive but resectable carcinoma of the upper portion of the stomach was found. During this dissection, there occurred a capsular tear of the spleen which necessitated simple excision of that organ. While dissecting along the lesser curvature, there was a severe fall in the blood pressure to 80 mm. systolic. Transfusion had already begun and this fall in blood pressure was out of proportion to the measured blood loss at that time. Without explanation for the attending shock, no further surgical manipulation was carried out and supportive measures were instituted. The anesthetic agent was changed to cyclopropane and the patient was given ample amounts of oxygen as well as procaine hydrochloride intravenously. There were further transfusions of blood intravenously. No improvement in the blood pressure was noted and closure of the abdomen was begun. During closure, and just before closure, it was noted that there was a beginning generalized oozing or bleeding from all cut surfaces of the abdomen. The abdomen was closely examined for active bleeders, none being found. The venous clotting time (Lee-White method) and the bleeding time were found to be normal at this time; platelet count was reduced. The abdomen was closed after insertion of a drainage tube to serve as an indication to the extent of bleeding. The patient was given 72 mg. of Vitamin K intravenously, 15 cc. (150 mg.) of protamine intravenously, one ampule of antihemophylic globulin (Fraction I) and 5 Gm. of calcium gluconate intravenously at varying intervals. By this time the patient had received six transfusions of blood intravenously and the pressure continued to

*Pentothal-curare mixture, intravenously, with nitrous oxide and oxygen intratracheally.

decline to 50 mm. systolic. For this reason, intra-arterial transfusion was begun into the brachial artery which produced an immediate elevation of blood pressure to the patient's normal limits of 120 mm. of mercury systolic. There was general improvement in the patient except for continued bleeding from the abdominal drainage tube. A little over an hour later the intra-arterial transfusion was transferred to the left femoral artery because the hand distal to the cannulated brachial artery had become dusky. The brachial artery was re-anastomosed and the color and pulse returned immediately. At this time direct transfusions of fresh blood from two donors taken to the operating room were given to the patient, utilizing a 50 cc. syringe with a three-way stop cock and dry film tubing. One thousand cc. of fresh blood given in this manner failed to stop the oozing and there remained a steady stream of blood coming from the abdominal drain, and continuous transfusion intra-arterially was necessary to maintain the blood pressure. The patient also received, at this time, 71 mg. of toluidine blue (1 mg. per kilogram of body weight) intravenously without beneficial effect. (It has since been found that this dose is not sufficient to counteract the suspected heparinemia.) The abdomen of this patient was re-explored at this time as a final search for an unrecognized active bleeder by route of the same incision under ether anesthesia, while little was needed. Again, it was found that the entire surface of the previous dissection and abdominal wall oozed markedly. The entire area was packed off; the abdomen closed with compression sutures of wire and as a last resort, human thrombin 6 cc. (500 units per cc.) was given intravenously without cessation of bleeding. The patient was given intra-arterial transfusions of blood until he expired 15 hours after the onset of the first blood transfusions. Additional pertinent laboratory work included a plasma hemoglobin of 100 mg. per hundred cc. and a urine hemoglobin of .2 Gm. per litre, the volume during surgery being 194 cc. The early blood given to this patient was found to be compatible by the usual means. Postmortem examination was not granted.

CASE 2. F. P., a 73 year old female, blood group O Rh pos., entered the hospital with symptoms of pyloric obstruction. Following preoperative preparation with blood transfusions, the patient was operated upon under ether anesthesia. Eight cc. of Baird's solution was given intravenously during abdominal closure. A prepyloric ulcer with fistulization to a calcified gallbladder containing stones was found. The intestinal obstruction was due to a mass of gallstones matted together within the duodenal lumen just beyond the pylorus. A cholecystectomy and partial gastrectomy were performed without event. The measured blood loss was about 1500 cc., which was adequately replaced by intravenous blood transfusions. One gram of calcium was given following the third transfusion. Approximately one-half hour after completion of the operation, the blood pressure fell suddenly to imperceptible levels. This was attended by, or preceded by, the observation that blood was coming from the drainage site at a rapid rate not in keeping with the usual postoperative bleeding. Ephedrine and further transfusions failed to elevate the blood pressure and the patient was moved from the recovery room into the operating room for immediate re-exploration. The peritoneal cavity contained about two litres of blood and it was noted that all the surfaces of the surgical wound were bleeding profusely without active bleeders. The wound was packed and the abdomen closed. The patient, prior to re-exploration, was given 70 mg. of toluidine blue (an insufficient dose), one ampule of antihemophylic globulin (Fraction I)

and 72 mg. of Vitamin K, as well as 1000 mg. of Vitamin C intravenously. During re-exploration, the patient also received fresh blood by the indirect method. Plasma hemoglobin determinations obtained from two sites simultaneously were reported as 157 mg. per hundred cc. The prothrombin time, clotting time, bleeding time and platelet count were reported as normal. The patient became anuric and expired four hours following the second exploration. A recheck on all the blood given showed that it had been properly cross matched as nearly as these tests could determine. Postmortem examination was noncontributory.

CASE 3. V. K., a 43 year old female, blood group A Rh pos., entered the hospital with a nontoxic substernal thyroid enlargement. One week prior to operation the patient received transfusion of supposedly compatible blood and a severe reaction ensued with fever, back pain and respiratory difficulty. Under anesthesia of Baird's solution, the substernal goiter was surgically removed.* During the procedure two bottles of whole blood were given intravenously. As the patient was coming out of anesthesia, she suffered a reaction similar to that which she had experienced one week prior, consisting of dyspnea, a flushed appearance of the skin and sudden elevation of temperature to 105 F. Shortly after surgery, the patient was noted to be bleeding excessively from the surgical wound and she was returned to the operating room. There was no depression of the blood pressure when the bleeding was first noted. However, the blood pressure, upon return to the operating room, was first recorded at 70 mm. of mercury systolic. A vein was cannulated and massive transfusion therapy begun. The reopened surgical wound demonstrated a marked oozing of blood from all surfaces. The patient expired rather promptly before laboratory determinations could be obtained or specific therapy instituted. A sample of blood taken from the wound failed to clot. A limited postmortem examination revealed hemorrhage in the right lung and subpleural diaphragmatic surfaces with hemorrhagic exudate in the bronchi.

CASE 4. J. E., a 53 year old male, blood group O Rh pos., entered the hospital with a diagnosis of chronic duodenal ulcer. There was also obstruction of the efferent loop of a previous gastroenterostomy. Preoperative preparation included transfusions of whole blood without apparent reaction. The patient was operated upon under anesthesia of Baird's solution with nitrous oxide and oxygen. The enterostomy loop was excised, the duodenojejunostomy completed, and gastric resection was being carried out at the time oozing of blood from the surgical wound was first detected. The oozing of blood was first noted one hour following the beginning of the infusion of the first bottle of blood. The first fall in blood pressure occurred one-half hour after the oozing was first noted. The patient received ephedrine, neosynephrine, Vitamin K (72 mg.) intravenously, as well as infusions of blood by both intravenous and intra-arterial routes. At a point when the patient had received one litre of blood, the platelet count was found to be 74,000; a splenectomy was consequently done without change in the patient's course. The patient expired in a relatively short period of time, one and one-half hours after the first blood pressure fall, or three hours after the first blood transfusion was begun, during which time

*Operation by Dr. I. D. Baronofsky.

he received 15 pints of blood. The fulminating course did not allow detailed laboratory study or specific therapy. Postmortem examination revealed a hemothorax, hemoperitoneum, and hemopericardium.

CASE 5. V. H., a 22 year old male, entered the hospital with a diagnosis of chronic duodenal ulcer. There had been gastrointestinal hemorrhage which was treated by numerous transfusions. Under anesthesia of Baird's solution, a subtotal gastrectomy was performed,* during which time the patient received three bottles of whole blood without event. Immediately postoperatively, however, the hemoglobin was found to be 7.5 Gm. per hundred cc. and the blood pressure fell to sharp levels. The patient was given 3000 cc. of whole blood intravenously and surgical re-exploration was carried out three hours after operation. At the time of re-exploration the peritoneal cavity contained much blood and there was generalized massive oozing from all surfaces without active bleeding sites susceptible to ligature. The clotting time and bleeding time pre and postoperatively were within normal limits. The platelet count following re-exploration was reported at 48,000. A bone marrow examination showed abnormal platelet formation without eosinophilia or increased megakaryocyte count. The patient expired approximately 36 hours following surgery. Postmortem examination demonstrated massive abdominal pulmonary and serosal hemorrhages, pulmonary edema, and hemorrhagic bullous cystitis.

CASE 6. W. R., a 58 year old male, entered the hospital with a diagnosis of a large perforating stomal ulcer with episodes of hemorrhage. There was a history of gastrointestinal bleeding, a perforated gastric ulcer, a 50 per cent gastric resection, and a cholecystectomy, in three separate hospitalizations. The patient stated that he had received approximately 50 to 60 blood transfusions before admission with several severe reactions consisting of chills and fever. Because of this history, many preoperative laboratory determinations concerning liver function and the coagulation mechanism were performed, all values being within normal limits. Physical examination revealed moderate epigastric tenderness and a palpably enlarged spleen. The hemoglobin was restored to normal with repeated transfusions of whole blood, all of which were accompanied by reactions. Because of the history of frequent episodes of hemorrhage to severe anemic levels, he was subjected to operation under anesthesia of Baird's solution. At operation the first bottle of blood infused was begun when the measured blood loss was 20 cc. It was noted early in the operation that there was oozing from the incised surfaces to the extent that by the time the incision had reached the peritoneal layer, there had already occurred a measured blood loss of 370 cc. Without further dissection, laboratory procedures were carried out. There was a normal capillary clotting time and bleeding time; a venous clotting time as determined by the Lee-White method of 20 minutes, which was considered not significantly altered from the normal; a platelet count of 64,000, and a normal prothrombin time. A bone marrow aspiration at this time was reported to reveal a reduced number of platelets in the marrow, an elevated number of megakaryocytes, as well as "toxic" changes in the neutrophils. There was moderate marrow eosinophilia. The anesthetic agent was changed to ether and the abdomen was closed by means of compression sutures of wire. The blood pressure and pulse remained normal through

*Operation by Dr. O. H. Wangensteen.

the operative procedure. Postoperatively, there continued to be evidence of decreased circulating platelets, and a plasma hemoglobin of 205 mg. per hundred cc. In nine days the platelets had returned to the normal value of 218,000 to 230,000. There was no further evidence of bleeding from the surgical wound. However, he continued to lose blood from the stomal ulcer so that 11 days following operation his hemoglobin had fallen to 8.5 Gm. per hundred cc. and a transfusion of "compatible" blood was given. Following this, the patient became disoriented temporarily. A Lee-White clotting time was reported at 27 minutes which, within two hours, decreased to 12 minutes. The platelet count was 136,000 at this time. The patient was given 5 cc. of antihemophylic globulin. No further transfusions were given and no similar episodes recurred. He was discharged from the hospital under medical regimen for the stomal ulcer. Six weeks later the patient was readmitted to the hospital complaining of severe epigastric pain. During this hospitalization normal values for bleeding, clotting and prothrombin times were obtained as well as a normal platelet count. A splenectomy was performed with a blood loss commensurate with dense peritoneal adhesions and apparent portal hypertension. The previous generalized ooze was not noted at this time. Eight days following the splenectomy, the platelets were reported at 444,000. Pathological study of the spleen revealed no significant splenic lesion, but there were found hepatoma cells in the splenic vein, persumably embolic, from a primary hepatoma of the liver.

CASE 7. H. McC., a 37 year old male, blood group B Rh pos., entered the hospital for thoracoplasty on the right side because of severe mediastinal shift following a right pneumonectomy for diffuse bronchiectasis. Under ether anesthesia a first stage thoracoplasty was performed without difficulty. Toward the completion of the operation and during closure of the skin, it was noted that oozing of blood from the wound was present. This was noted within 30 minutes following the addition of a second bottle of blood. There had been previous transfusions with previous admissions of this patient to the hospital. No special significance was attached to the oozing at closure, and a pressure dressing was applied. The patient returned to the ward in good condition. Approximately one and one-half hours following operation it was noted that much blood was present under the skin and in the dressing. The blood pressure began to decline and he was taken to the operating room. The wound was opened, and it was noted that all surfaces of the wound were bleeding. Pressure and application of topical thrombin did not control the hemorrhage and hemostasis was finally accomplished only by the use of open packing in the chest wound. At this point, the presence of urticaria was observed and the patient was given antihistaminics intravenously and intramuscularly. The following day the icteric index was 18 units; the Vandenberg presented an indirect reaction of 2.6 mg. per hundred cc. The hemoglobin fell to 9.5 Gm. per hundred cc. and the erythrocyte count dropped to 3,110,000. There was marked hemoglobinuria, as well as albuminuria and casts packed with erythrocytes in the urine. The patient gradually recovered after a transient oliguria. There was a marked but transient jaundice in the patient following this reaction. Reexamination of the second bottle of blood given this patient proved it to be of a heterologous type, Type A, Rh positive. The patient was typed as Type B, Rh positive.

Discussion and Analysis of Cases

It is quite apparent from the description of the above cases that when generalized bleeding is superimposed upon an operation, which has progressed to a point of an extensive area of dissection, little hope of preventing death by exsanguination exists. Perhaps larger doses of protamine and toluidine blue would have aided in the recovery of more of these patients. The intravenous injection of human thrombin in one patient, P. B., a maneuver which is dangerous and usually fatal,[23] did not decrease the bleeding or alter the course of circumstances in this patient; neither was it the cause of death. Two patients recovered simply because, at early recognition of bleeding, the surgical wounds were superficial and amenable to mechanical compression or open packing.

All 7 cases in which bleeding occurred require analysis from several aspects as to (1) the possible inciting agent or agents, as well as (2) the modus operandi of the bleeding itself.

1. The presence of transfusion reactions, per se, in these patients is suggested in several ways. All patients had received previous transfusions of whole blood with known previous untoward reactions in 4 (P. B., V. K., W. R., and H. McC.). In 1 patient, W. R., who had previously received 50 to 60 transfusions, reactions occurred almost uniformly and crossmatching was exceedingly difficult. Needless to say, all patients were receiving blood when the bleeding began. Clinical signs of transfusion reactions (pyrogenic, hemolytic or anaphylactic) were present, and include sudden elevation of temperature after termination of anesthesia (V. K.), urticaria and jaundice (H. McC.) and sudden shock out of proportion to blood loss (P. B.). It should be mentioned here that the usual clinical signs of transfusion reactions are not manifest during anesthesia. Other evidence suggesting anaphylaxis is represented by reduced circulating platelets (J. E., V. H., W. R.), and occasional elevated clotting time, and visible bleeding in all. Laboratory evidence of hemolysis as measured hemoglobinemia, hemoglobinuria, elevated icteric index, and serum bilirubin is present in 4 (P. B., F. P., W. R., and H. McC.), with subsequent renal injury in one (H. McC.). There is conclusive evidence that 1 patient (H. McC., blood Type B, Rh positive) received one transfusion of blood of a heterologous group Type A, Rh positive. Prior to surgery the blood had been considered compatible because no agglutination was present on routine crossmatching. In this case bleeding began after 250 cc. had been administered. Determinations of subgroup differences other than major Rh factors were not done in any of the cases.

Shock, per se, with its attending tissue anoxia, may be suggested as the factor responsible for the bleeding in these patients. It should be noted, however, that shock was not present in one (W. R.) and was preceded by bleeding in all but 2 cases. In 1 case (F. P.), bleeding was noted simultaneously or just prior to a fall in blood pressure and in the other (P. B.), a precipitous fall in blood pressure, which was considered anaphylactic and not attributable to surgical blood loss, did precede the observation of bleeding.

That the bleeding might be an unexplained manifestation due to toxicity of anesthetic agents or a sensitivity of the patients to them, has been repeatedly suggested. In 5 of the 7 cases, anesthesia was primarily Baird's solution (Curare-pentothal mixture intravenously, with nitrous oxide and oxygen intratracheally); changes to cyclopropane and ether were made after the onset of bleeding in 2 of the 5 cases. The supposition that this anesthetic might be responsible for the occurrence of bleeding was possibly predicated on the fact that, experimentally, gastrointestinal hemorrhage has been reported to follow the use of pentothal and curare in dogs.[24] It is observed, first, that the dosages of these anesthetic agents employed in these experiments are massive and far in excess of the amounts used clinically in patients. Second, it is noted that hemorrhage does not occur when the shock, associated with the large doses of curare, is prevented.

Intratracheal ether was the primary anesthetic agent in 2 of the 7 cases presented. In 1, however (F. P.), a small amount of Baird's solution (8 cc. intravenously) was given at the completion of the operative procedure for abdominal closure, shortly before the noted onset of bleeding. One cannot exclude the circumstance that the time factor in this case suggests a cause and effect relationship; on the other hand it seems unlikely that the small quantity of solution injected should so profoundly alter the patient's course. In the seventh case (H. McC.), in which there is unequivocal evidence of the syndrome developing subsequent to the infusion of 250 cc. of blood of a heterologous group, the anesthetic agent employed was ether.

If hepatic dysfunction occurred as the result of injurious action by any of the anesthetic agents, one might reasonably expect to obtain altered prothrombin determinations as well as possible alleviation of the bleeding by massive doses of Vitamin K and fresh blood administered in most of the patients. Oxygen was given in association with the anesthetic agents in all patients.

A bacteriologic basis for a syndrome similar to these described has been suggested. The presence of a hemolytic organism in the

infused blood, fluid or equipment would substantiate such a suggestion. Unfortunately, there is no record of bacterial cultures in any of the described instances.

2. The laboratory data available, admittedly incomplete, together with the results of specific hematologic therapy employed, throw very little light on the nature of the coagulation defect or bleeding tendency in these patients. As has been referred to, the finding of appreciably reduced platelets in 3 patients is probably significant. The variable coagulation times, normal bleeding and prothrombin times add little of note. Bone marrow aspirations obtained during two of these episodes revealed elevated megakaryocytes, a reduced number of platelets and moderate eosinophilia in 1, and reduced platelet formation in the other. No determinations were carried out concerning heparin content, antithrombin activity or factors of fibrinolysis. Specific therapy was directed to ostensibly all possible defects in the clotting mechanism. Protamine and toluidine blue, as well as human thrombin intravenously, were given to counteract the theoretical release of circulating heparin or antithrombin. In the dosages employed, probably inadequate, they exerted no beneficial effect clinically. Fresh blood, transfused directly or indirectly, was of no avail. Vitamin K was given for a possible prothrombin deficiency. Calcium was injected repeatedly during all operations to aid in the clotting mechanism generally, and to prevent possible citrate reactions, improbable, however, in adults. Antihemophylic globulin (Fraction I) was administered for its effect on the clotting times as seen in familial hemophilia. Vitamin C and procaine hydrochloride were injected intravenously for their general effects on capillary permeability and anaphylaxis, respectively. Antihistaminics were employed in 1 patient who survived the syndrome; what direct effect they may have had is not known. Topical thrombin was applied locally without apparent arrest of the oozing. The indication for splenectomy was the low platelet counts obtained. The similarity to thrombocytopenic purpura is obvious, although it is known that splenectomy does not prevent thrombopenia of anaphylaxis in experimental dogs. Supportive therapy included further transfusion of whole blood and plasma intravenously and intra-arterially, oxygen intratracheally, ephedrine, neosynephrine and adrenalin. Early recognition and the use of efficient packing in superficial wounds played an important role in obviating what might have been fatal consequences for 2 patients.

The 7 cases described here were observed in a period of three and one-half years. It is notable that 5 occurred in a six months' period, 3 within the same month. Exploration of the obvious significance of these closely repeated occurrences concerning the technical match-

ing and handling of blood has not been informative. The case in which proof of mismatching was obtained took place in another hospital one year later than the remaining cases. All cases except 2 were operated upon by one of us (S. R. F.).

SUMMARY

A syndrome is described in which there occurs, during or immediately after operation, a massive generalized hemorrhage in the surgical wound, of insidious onset. The bleeding, in the form of an "ooze," is virtually refractory to most methods of hemostasis, mechanical and chemical. Seven such cases are presented; a fatal outcome was observed in 5 of the patients. Early recognition resulted in the salvage of 2 patients; the surgical wound, situated peripherally, being susceptible to hemostasis by packing. The majority of evidence obtained tends to incriminate blood transfusion reactions of the hemolytic type as the inciting agent. A significant reduction of circulating platelets, as determined in some of these patients, appears to play a part in the bleeding dyscrasia, although the nature of the defect in the clotting mechanism is unknown.

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THE AMPULLA OF VATER AND PANCREATITIS

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NO PHASE of pancreatitis can be discussed without first recognizing the influence of the ampulla of Vater and its intricate system of control on flow along the biliary and pancreatic ducts. The normal purpose of the sphincter and its extension along the common bile duct is to force bile into the gallbladder reservoir while preventing regurgitation into the pancreatic duct and, conversely, to permit passage of bile into the duodenum by reciprocal relaxation of the sphincter when the gallbladder contracts.

Definition: Vater's ampulla is a dilatation of the common tube formed by the union of the common bile duct and pancreatic duct, just above its entrance into the duodenum.

Embryology: It arises from the common zone of attachment to the primitive foregut of the ventral pancreas and hepatic primordium in the 26 mm. embryo, and lies in the duodenal submucosa, completely developed at 7 months.[1]

Physiology and Pharmacology: The passage of biliary and pancreatic secretions through the ampulla is controlled by the actions of a specialized muscle, the sphincter of Oddi, described by Francis Glisson in 1654. Oddi, in 1887, demonstrated the presence of the sphincter in many animals and measured its resistance. In addition, he noted dilatation of the biliary system after removal of the gallbladder, and postulated that dysfunction of this occluding apparatus might explain certain morbid affections of the biliary tract.[2]

Separation of pancreatic from biliary secretion is affected by the circular fibers around the lower end of the common duct, and thus a column of bile can be retained even in the presence of a copious flow of pancreatic juice.[2,3] Spasm of the common duct sphincter can be relaxed by the presence of intraduodenal magnesium sulphate,[3] or can be prevented to a large degree by atropinization. On the other hand, morphine sulphate precipitates spasm of the sphincter which may last for hours, and may cause regurgitation of bile into the pancreatic duct.[4,5,6] This action of morphine is minimized by simultaneous administration of atropine.

Recent pharmacological studies by Thiessen using direct observations on the sphincter of dogs showed that normally it undergoes a slow rhythmic contraction every 2 to 6 seconds.[7] An increase in tone was seen after calcium chloride intravenously, a hypodermic of adrenaline, or morphine sulphate. A decrease in tone was seen

after inhalation of amyl nitrite or the topical application of one-tenth normal hydrochloric acid to the duodenal mucosa. He likewise found that faradic stimulation of the peripheral end of the cut right vagus nerve caused a contraction of the sphincter, whereas stimulation of the central end of the right or either end of the divided left vagus nerve had no effect.

Though the nerve supply to the sphincter of Oddi is not well known, a few generalizations may be considered. Paynter Holt stated that anything which constricts the blood supply to the biliary system will cause constriction of the sphincter of Oddi.[8] Walters and Shell stated that vagal stimulation produces general spastic contraction of the gallbladder and sphincter of Oddi and cessation of bile flow. However, sympathetic splanchnic stimulation, while causing relaxation of the gallbladder, still produces contraction of the sphincter.[9] Thus it might seem that there are no true inhibitory fibers to the sphincter, and that relaxation is a passive rather than an active function.

Patho-physiology: Obstruction to the pancreatic duct somewhere along the line is the first step in the pathogenesis of pancreatitis.[10,11,12] The most likely location for obstruction is at the ampulla of Vater, whether from spasm, stricture, or stone.

We have already mentioned that retrograde flow back up the common duct is prevented by circular fibers around the lower end of the common duct, and thus in the presence of hypertrophy of the ampullary sphincter or stenotic narrowing of the orifice, the so-called "ejaculatory" longitudinal fibers of the sphincter of Oddi whose normal function is to empty the ampulla, may be responsible for reflux of bile into the pancreatic duct.[2] This is the basis upon which the common channel theory of Opie[13] is based[10,11,12,14] and closer study of more recent cases uniformly reveals evidence corroborating these findings.

Rupture of the pancreatic duct, though minute, is the next step in the pathogenesis of pancreatitis. The mere presence of bile in pancreatic ducts alone is not a factor in pancreatitis unless the duct wall is ruptured. Interstitial leakage of bile and pancreatic secretions with activated enzymes, or the difference in pH produced, may so stimulate nerve endings as to precipitate a widespread sympathetic reflex inducing spasm of the blood vessels and ducts.[10]

The vasospasm thus produced interferes with the circulation through the pancreas which may be of sufficient degree that ischemic necrosis follows, which is familiar to us as acute pancreatic necrosis (hemorrhagic) or acute pancreatic edema. The degree of damage

to the pancreas is dependent upon several factors, varying directly with the enzyme level or the amount of ductal obstruction.

Recently, there is an accumulation of new evidence correlating the degree of damage with the degree of circulatory interference.[10,15] Pure pancreatic juice (i.e. trypsinogen) will not digest meat for weeks, but after the addition of intestinal juices to the mixture the meat is quickly digested,[8] as the trypsinogen is activated to trypsin. Inasmuch as the sphincter of Oddi prevents regurgitation of intestinal juices into the obstructed common duct, it is difficult to place much credence in "the autodigestion theory" as the cause of pancreatic necrosis or injury.

The association of gallbladder disease with pancreatitis has been reported consistently. The correlation may be as high as 90 per cent. On the other hand, during the course of acute cholecystitis, concurrent acute pancreatitis is not uncommon, the reported incidence varying from 3 to 23 per cent. In my own experience, every case of pancreatitis I have seen has had an accompanying cholecystitis.

Outline of Treatment: Immediate treatment is directed toward support of the patient:

1. Relief of Pain.
    a. Opiate and atropine.
    b. Splanchnic procaine anesthesia.
    c. Gastroduodenal suction.
2. Prevention of Shock.
    Intravenous glucose, plasma, blood and oxygen.

The first step is usually the use of opiates. Inasmuch as most of the common opiates otherwise are likely to accentuate spasm of the sphincter of Oddi, as has been discussed under physiology, the concomitant use of atropine is essential. It may be noted that morphine, which usually gives most consistent relief of pain, produces the highest degree of spasm of the sphincter, with demerol and codeine following in that order.[16] This action of morphine on the sphincter at times may accentuate the pain unless atropine is given.

Splanchnic anesthesia does more than relieve visceral pain, for it is seldom necessary to repeat the procedure. The severe pain does not return,[10,14] whereas the severe pain of renal colic, high intestinal obstruction, acute cholecystitis, or acute duodenal ulcer nearly always returns in 20 to 30 minutes. We feel that this is due to relief of the acute pancreatic vasospasm and ischemia by vasodilatation

from sympathetic anesthesia. Anesthesia of the vagal fibers blocks one source of enzyme secretion and assists in placing the pancreas at rest. Clinical observation and dog experiments[17] confirm this hypothesis.

Decompression of the upper gastrointestinal tract and of the biliary tract,[18,19] if the diagnosis is made by abdominal exploration, tends to stop the process. Certainly, spinal anesthesia with its sympathetic block is the anesthetic of choice as compared with inhalation anesthesia.

Later treatment directs attention to the ampulla of Vater, and dilatation or section of the sphincter of Oddi must be done to prevent recurrences of pancreatitis,[10,12] or the postcholecystectomy syndrome. It is not enough to say *pancreatitis never recurs after cholecystectomy* or that *they all do all right after cholecystostomy*. Sixty-three per cent[18] to 71 per cent[21] of patients with pancreatitis have the history of "previous similar attacks." On the other hand, while it is reliably stated[21] that pancreatitis recurs in about half the patients and that cholecystectomy, with or without common duct exploration, does not prevent recurrences of pancreatitis, no mention was made by these authors of a plastic procedure on the ampulla which is the key to proper treatment.

After the acute inflammatory reaction subsides in 3 to 10 weeks, with evidence of gallbladder disease, cholecystectomy and choledochotomy are performed. We feel that a plastic procedure on the ampulla of Vater and sphincter of Oddi is mandatory, and we further feel that with omission of this step an incomplete operation has been performed. The choices for a plastic procedure lie between a sphincterotomy, endocholedochol or transduodenal, and an endocholedochol dilatation of the sphincter with Bake's dilators. A splanchnicectomy of some sort to relieve chronic pain is a step which logically should not be taken until an adequate plastic procedure has been performed on the ampulla of Vater, but no hard and fast rules shall be given this finer point now. Splanchnicectomy does relieve certain types of chronic visceral pain arising from the pancreas, besides relieving spasm of the sphincter of Oddi.

Summary

It has been long recognized that the ampulla of Vater and its sphincter mechanism regulated the biliary and pancreatic flow, and gallbladder filling.

A plea for proper surgical attention to this sphincter organ during the treatment period of pancreatitis has been made.

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DRAMAMINE IN GENERAL SURGERY*

A Comparative Clinical Evaluation

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Clinical observations[1,2,3] demonstrate dramamine (B-dimethyl-amino-ethyl benzohydryl ether 8-chlorotheophyllinate) to be effective in the prophylaxis and treatment of motion sickness. Other investigators[4,5] suggest its usefulness in post electro-shock nausea and the nausea and vomiting of pregnancy. A small series of cases recently reported by Brentan[6] indicates the effectiveness of this drug in the treatment of migraine.

Beller of the Mayo Clinic, noting the parallelism between the symptoms of motion sickness and those of radiation sickness, used this drug for the treatment of the latter in 82 patients. The excellent results obtained by him suggested to us the possibility of using dramamine in the prophylaxis and treatment of postoperative nausea and emesis. In view of the fact that radiation sickness is not associated with motion, and that the mode and site of action of dramamine have not been determined, it seems logical to test its application to the field of surgery.

In 100 consecutive surgical cases, all pre and postoperative treatment was standardized with the exception that the first 50 patients received dramamine and the remaining 50 did not. Dosage of this drug was 50 mg. the night before surgery, 50 mg. early the morning of surgery and 50 mg. every 8 hours for a minimum of 3 days.

Classification of the degree of severity of nausea and emesis was recorded as follows:

1. Group I, emesis none, nausea none or negligible.
2. Group II, emesis mild, nausea of less than 24 hours' duration.
3. Group III, nausea and emesis of greater than 24 hours' duration.

Charts I and II afford a comparative group of surgical procedures. In those receiving dramamine, 30 or 60 per cent had little or no nausea and no emesis; 13 or 26 per cent were in Group II and 7 or 14 per cent in Group III. In chart II, those who did not re-

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CHART I

	Total	Gp I	Gp II	Gp III
Amputation of leg	1	1		
Appendectomies	3	3		
Colon surgery				
Abdomino-perineal	1		1	
Colostomy	1			1
Ileo-colectomy	1		1	
Excision Roux/Y & exploration common duct	1	1		
Biliary tract				
Cholecystectomy (acute)	1			1
Cholecystectomy (chronic)	3		2	1
Exploration common duct	1			1
Excision cerv. tumor (Boeck's sarcoid)	1	1		
Excision inguinal granuloma	1	1		
Excision pilonidal cyst	1	1		
Herniorraphies				
Diaphragmatic	1	1		
Epigastric	1		1	
Incisional	1		1	
Inguinal				
Unilateral	6	4		2
Bilateral	1		1	
Umbilical	1	1		
Mastectomies				
Radical	2	2		
Simple	4	2	2	
Skin recurrence	1	1		
Orchidectomy	1	1		
Pelvic surgery				
Hysterectomies	4	3	1	
Other pelvic procedures	2	1	1	
Perineal procedures	2	1	1	
Rup. tubo-ovarian abscess with gen. peritonitis	1	1		
Sympathectomy (lumbar)	1	1		
Torsion omentum	1		1	
Thyroidectomy	2	1		1
Stripping varicose veins	2	2		
TOTAL	50	30 60%	13 26%	7 14%

These patients received dramamine 50 mg. the night prior to surgery, early on the morning of surgery and every eight hours postoperatively for a minimum of 3 days.

ceive dramamine, the results were almost identical; 31 or 62 per cent were classified into Group I, no emesis, slight or no nausea; 13 or 26 per cent in Group II; 6 or 12 per cent in Group III.

CHART II

	Total	Gp I	Gp II	Gp III
Amputation hand	1	1		
Appendectomies				
Acute	1		1	
Perforation	5	3	1	1
Abdomino-perineal resection	1			1
Biopsy carcinoma liver	1	1		
Small bowel resection	1		1	
Cholecystectomies				
Acute	2		1	1
Ruptured	1	1		
Chronic	2		1	1
Hand-plastic	2	1	1	
Herniae				
Umbilical	2	2		
Inguinal	4	4		
Diaphragmatic	1	1		
Epigastric	1	1		
Mastectomies				
Radical	3	2	1	
Simple	4	2	2	
Gastric surgery				
Gastrectomies	3	2	1	
Gastrectomy and cholecystectomy	1	1		
Gastrotomy	1		1	
Vagotomy	1	1		
Parotid tumor	1	1		
Pelvic surgery				
Hysterectomies	2	1	1	
Ectopic pregnancy	1			1
Pelvic	1	1		
Perineal	3	3		
Tuberculous salpingitis and recto-vesicle fistula	1			1
Pilonidal cyst excision	1	1		
Thyroidectomy	1		1	
Vein stripping	1	1		
TOTAL	50	31	13	6
		62%	26%	12%

Patients not receiving dramamine.

Of interest was the results in 3 patients receiving dramamine. These patients suffered no nausea or emesis. This was a marked contrast to their previous postoperative surgical experiences. It may be further noted that no gastric cases are listed in chart I, because continuous suction drainage was used, preventing use of any oral medication.

Conclusion

Dramamine at the oral dosage of 50 mg. the night before surgery, 50 mg. in the morning of surgery and 50 mg. every 8 hours postoperatively was not effective in reducing postoperative nausea and emesis.

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RETROPERITONEAL TUMORS

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RETROPERITONEAL tumors were first discussed before a medical group at a meeting of the Southern Surgical Association in 1897 by Dr. Richard Douglas. Primary retroperitoneal tumors are those arising in the areolar space behind the peritoneum and in front of the posterior wall of the abdomen. This space extends from the diaphragm to the true pelvis. The tumor is regarded as retroperitoneal, even though it extends into the mesentery, provided it arises in the areolar space. These tumors must be unattached to adult structures.

Over 500 cases of retroperitoneal tumors have been reported in the literature. Beahrs, Judd and Dockerty reported 174 cases of abdominal mesenteric, omental, and retroperitoneal cysts at the Mayo Clinic from 1911 to 1947. Nine of these were chylous cysts. Of these 9 cases, 2, or 22 per cent, were malignant. One was an endothelioma of the lymphangial type and one a lymphangio-endothelioma. According to Nichols, Whipple, Newman and Pinck, retroperitoneal lymphangiomas are rare, only 8 cases being reported in the literature. One of the 3 cases presented here is a cystic lymphangioma.

In a review of the cases at the University of Oklahoma during the past five years we were able to collect only 13 cases which we considered fulfilled the criteria for primary retroperitoneal tumors. In this series were 3 neuroblastomas, 4 fibrosarcomas, 2 lymphosarcomas, 1 lipo-myxosarcoma, 1 cystic lymphangioma, 1 dermoid cyst, and 1 teratoma. A follow-up shows 9 patients dead and 4 living. The patients now living are 1 with a fibrosarcoma, 1 with a cystic lymphangioma, 1 with a teratoma and 1 with a dermoid cyst. The etiology of these tumors has been adequately described by Handfield-Jones in 1924 and Hansmann and Budd in 1931. Most solid retroperitoneal tumors containing glomerular or ovarian elements are considered as arising in the mesonephros or urogenital ridge. Dermoid cysts might very well find their position due to inclusions of ectoderm early and before segmentation.

These tumors are usually painless because they have plenty of room and rarely encroach on other structures early in their course. The presenting symptoms are a more or less indefinitely palpable

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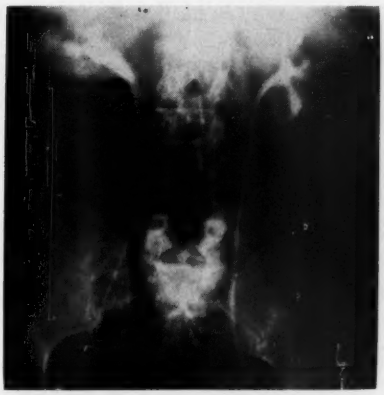
mass in the abdomen and a feeling of vague abdominal distress. In the differential diagnosis of retroperitoneal tumors, certain types of abdominal tumors must be considered. Those arising from the gastrointestinal tract, cysts of the pancreas, enlargements of the spleen, ovarian tumors, cysts of the omentum and mesentery, neoplasms of the liver and those tumors of renal origin must be kept in mind.



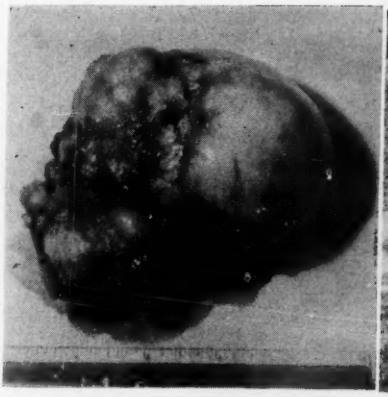
Case 1. Fig. 1. Mrs. Mac M. Intravenous pyelogram showing medial displacement of the ureter due to retroperitoneal lymphangioma.

Donnelly has emphasized that, to complete the differential diagnosis, x-ray examination is of prime importance. One must have studies of the gastrointestinal tract to determine the relationship between it and the palpable mass. There may be marked distortion and displacement of the various parts of the gastrointestinal tract, due to the size of the retroperitoneal tumor. Cholecystograms, pyelography of the kidneys and ureters are invaluable. Ureteral displacement is usually considered characteristic of primary retroperitoneal tumors. This is based on the anatomical fact that the ureters are quite adherent to the posterior parietal layer of the peritoneum, so that anything that displaces the ureter forward or to the side must necessarily be retroperitoneal in nature. Frequently calcification of the wall of these tumors narrows the diagnosis to pancreatic or renal cysts.

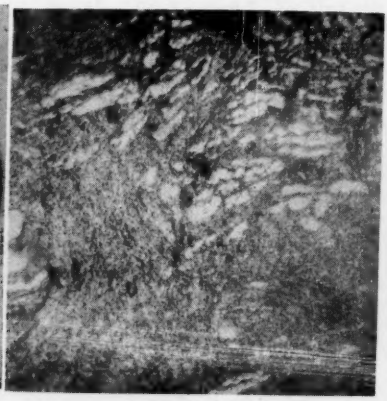
Case Reports

Case 1. Mrs. Mac M., a well developed, well nourished white female, 56 years of age, had known of a mass in her right side for the past 12 years.

Ten years ago she had an x-ray which showed a tumor with erosion of the bodies and the transverse processes of the first three lumbar vertebrae on the right side. During the past year the mass had increased in size and had become tender. Her only symptoms were a feeling of fullness in the right side and some flatulence.



Case 1. Fig. 2. Photograph of retroperitoneal lymphangioma.



Case 1. Fig. 3. Photomicrograph of retroperitoneal lymphangioma, showing well formed lymph channels lined by typical endothelial cells.

The general physical examination was negative, except for abdominal palpation. This showed a firm, fairly well fixed, slightly tender tumor mass in the right side of the abdomen, about midway between the costal margin and the crest of the ilium.

Intravenous pyelograms showed medial displacement of the right ureter. A barium enema showed the tumor to be behind the right colon, pushing it forward but not involving the bowel. A preoperative diagnosis of a retroperitoneal tumor was made.

At operation the mass was exposed by reflecting the posterior peritoneum medially. The tumor was well encapsulated, yellowish white, firm and shelled out fairly easily. The kidney and ureter were exposed, and damage to these structures was avoided during the procedure.

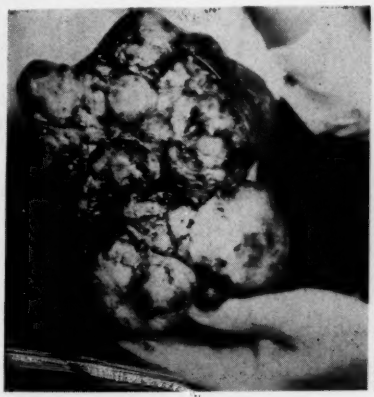
Microscopic examination showed a tumor composed of small fairly well differentiated mesenchymal cells which tended to fasciculation throughout; intercellular substance was comparatively abundant. Microscopic diagnosis: cystic lymphangioma.

Case 2. Mrs. P. N. K., a 70 year old white female, in November 1947 noticed a tumor in her right lower quadrant. The symptoms were vague and consisted chiefly of a fullness in the abdomen, especially after eating.

Examination showed an irregular, firm, slightly tender mass 8 by 10 cm. in the right lower quadrant.

Barium enema showed that the mass was not involving the colon. Intravenous pyelogram showed hydronephrosis of the right kidney, but otherwise no pathology.

At operation the tumor was found retroperitoneal, arising in the region of the superior mesenteric vessels and extending into the mesentery. The right colon was mobilized and the tumor freed from the retroperitoneal tissue. It was grayish yellow, nodular, moderately firm and measured 10 by 12 cm.



Case 2. Fig. 1. Mrs. P. N. K. Fibrosarcoma—recurrent retroperitoneal.

Case 2. Fig. 2. Photomicrograph—retroperitoneal fibrosarcoma.

Microscopic examination: fibroma with fibrosarcomatous areas. She made a rapid recovery and was given x-ray therapy upon dismissal from the hospital.

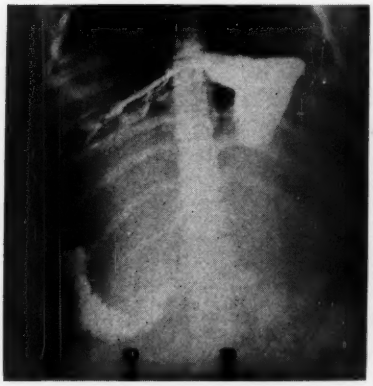
The tumor recurred after 2 years. Examination showed a hard, nodular, fixed tumor mass in the lower abdomen, more on the right side.

At operation a large mass which seemed to arise at the root of the mesentery could be visualized. The tumor was brought up with extreme difficulty; numerous portions of the bowel were adherent to the mesentery. In freeing the tumor, the jejunum was opened in three places. After the tumor was freed, a line of cleavage was encountered and the tumor gradually enucleated. The right ureter was adherent and grew through the posterior wall of the tumor. In delivering the tumor, the right ureter was severed. About 12 inches of the jejunum was resected and an end to end anastomosis was done.

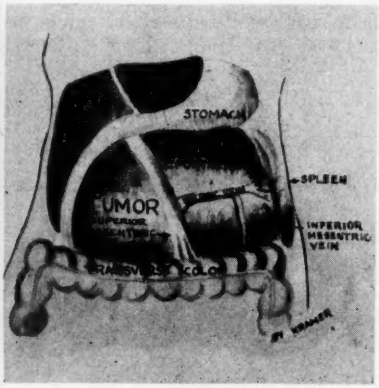
The tumor weighed 2800 Gm., was 18 cm. in diameter, grayish white, firm and roughly nodular. Microscopic diagnosis: fibrosarcoma. The tumor consisted of fasciculated large spindle-shaped cells with numerous blood vessels and scanty stroma.

CASE 3. Mrs. G. R., a 20 year old white female four to five months pregnant when seen in consultation with the obstetrician. She had been well all of her life with no complaint except an enlargement of her upper abdomen which had caused a shortness of breath and a feeling of fullness. Since the second month of pregnancy there had been an increase in the mass and the symptoms were aggravated by eating a full meal.

On physical examination there was a large rounded tumor mass with a semisolid to cystic consistency, 14 to 16 inches across, occupying the entire upper abdomen. The uterus was enlarged to 2 finger breadths below the umbilicus consistent with a four to five months pregnancy.

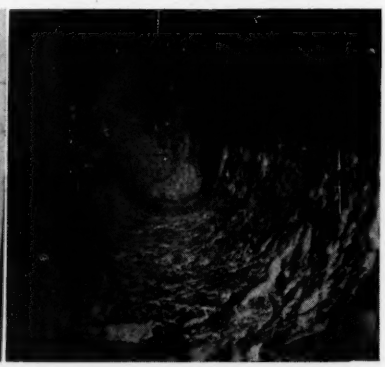


Case 3. Fig. 1. Mrs. G. R. Upper GI Series showing marked widening of the duodenal loop caused by large retroperitoneal dermoid.



Case 3. Fig. 2. Drawing showing the relationship of the tumor to the duodenum, portal, splenic and superior mesenteric veins.

Case 3. Fig. 3. Photograph of large retroperitoneal dermoid.



Case 3. Fig. 4. Photomicrograph of retroperitoneal dermoid cyst showing stratified squamous epithelium and rudimentary skin structures.

X-ray examination: An upper gastrointestinal series showed a marked widening of the duodenal loop with displacement of the stomach upward and to the left. Intravenous pyelograms showed a large, soft tissue mass occupying almost the entire right abdomen, with displacement of the ascending colon laterally. The kidneys and ureters were not definitely abnormal.

At operation a large tumor mass was exposed. Over the anterior surface of the mass were the portal, the superior mesenteric and splenic veins. These were dissected free and pushed to the left, rotating the tumor to the right side and freeing it from its attachment in the posterior areolar space.

The tumor was ovid, well encapsulated, cystic and measured 12 by 8 by 6 inches. It was filled with thick, white putty-like material, containing blond hair.

Microscopic examination revealed a dense, fibrous wall lined by thin stratified epithelium and in other areas a few rudimentary skin structures. Microscopic diagnosis: benign dermoid cyst.

Our conclusions are:

1. The treatment of primary retroperitoneal growths is surgical.

2. Radiotherapy has been found to be of value in prolonging life and improving the well-being of the patient, postoperatively.

3. Primary retroperitoneal tumors are not as rare as we have been led to believe.

4. It is therefore important that we have a clear understanding of the origin, diagnosis and treatment of these tumors.

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DIAPHRAGMATIC HERNIA IN THE NEWBORN

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THE prompt recognition and surgical correction of diaphragmatic hernia in the newborn infant has favorably altered the previously high mortality of this developmental anomaly. In the past the fallacy of expectant treatment frequently resulted in the death of an infant whose cardiorespiratory function was so seriously impaired. Although a few patients who harbor this defect at birth develop to childhood or adulthood, more commonly the condition is not compatible with life. The menace to life is attested by all interested in this problem.[1]

EMBRYOLOGY AND PATHOLOGY

When the complex development of the diaphragm is considered, it is remarkable that congenital defects do not occur more often.[2] The ventral division of the diaphragm takes its origin from the septum transversum, which in the early embryo divides the abdominal viscera from the heart. This septum, at first situated in the neck region, with its nerve supply derived from the third and fourth cervical nerves, migrates caudally until it assumes its final location at the level of the twelfth rib. At this point a union occurs between the septum transversum and a thickening of the mesodermal cells at the upper end of the dorsal mesentery, so that a partition is formed between the ventral and dorsal portions. However, an opening, the pleuroperitoneal canal, remains in each posterolateral section of the diaphragm for a certain interval of time. By the end of the fourth week a double fold of serous-membrane, originating from the pleura superiorly and from the peritoneum inferiorly, closes the canal. Later, ingrowth of muscle fibers between these layers takes place to complete the division of the pleural and peritoneal cavities. A failure of fusion of the various components involved in the development of the diaphragm results in an open communication between the pleural and peritoneal cavities. Faulty fusion predisposes to a weakened area.

Congenital diaphragmatic hernia may be found in one of the following sites:[3]

1. Pleuroperitoneal canal (foramen of Bochdalek), which is the most common location. Hernias occurring in this area are three to four times more common on the left side than on the right. This

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disproportion is due to the fact that the liver serves to partly occlude the right pleuroperitoneal canal. Hernias occurring through the pleuroperitoneal canal are without sacs in approximately 90 per cent of cases.

2. Esophageal hiatus. A hernia at this point may result either from a deficit of the circular muscle fibers of the hiatus, or may be due to a deficiency of the esophagus which is not elongated sufficiently to reach the diaphragm, thus allowing a portion of the stomach to reside above the diaphragm. A hernial sac is always present.

3. The retrosternal space (foramen of Morgagni or Larrey's space). This is the rarest location. A hernia in this region usually possesses a sac.

Clinical Considerations

The symptoms of a congenital diaphragmatic hernia may be respiratory, circulatory, or digestive in character. Often symptoms referable to all three systems are present. The degree of alteration of the cardiorespiratory mechanism is dependent upon the extent to which the abdominal viscera are displaced into the chest.[4] Although at times the normal physiologic relationship is only slightly disturbed, yet usually there is marked displacement of the abdominal viscera with resultant severe changes. The occurrence of symptoms due to an esophageal hiatus hernia is rare indeed during infancy. Evidence of obstruction of a portion of the gastrointestinal tract as a result of herniation, with or without hematemesis, is almost invariably reserved for later life. Likewise a hernia into the pericardial cavity is extremely rare. As indicated above, the pleuroperitoneal hiatus is by far the most common location of a congenital diaphragmatic hernia.

The presence of dyspnea, cyanosis, or vomiting within a very short time after delivery should immediately arouse the physician's suspicion of diaphragmatic hernia. Although cyanosis may occur only at times of feeding or when the infant cries, yet it may be apparent immediately after birth. Often one finds that continuous oxygen administration is necessary to maintain life. Vomiting may occur later. If the patient survives the first few weeks of life, a noticeable failure to gain weight and retardation of growth occurs.

Since compensatory cardiorespiratory reserves have not been sufficiently developed in the newborn infant, death may ensue within a few hours or days following birth.[5] On the other hand, if the heart and lungs are able to withstand this derangement, and obstruction of the intrathoracic loops of bowel does not occur, the infant

may live to childhood or even to adult life with symptoms that are either minimal or entirely absent. Often a diagnosis of congenital diaphragmatic hernia is reached on a routine x-ray examination of the chest. The element of intestinal obstruction is not nearly as great a hazard in congenital diaphragmatic hernia as in acquired or traumatic hernia since adhesions are practically unknown in the former.

Physical examination reveals a rapid pulse and respiratory rate. The excursion of the involved side of the chest is notably restricted. Percussion reveals dullness to hyperresonance, depending on whether the viscera present in the chest contain fluid or not. The breath sounds are either entirely absent or greatly diminished. Often gurgling sounds or borborygmi are elicited with the stethoscope. In the more severe cases, a displacement of cardiac dullness towards the unaffected side is noted.

Roentgenologic Findings

Roentgenologic study of the chest affords a relatively simple, rapid, positive means of establishing a diagnosis of congenital diaphragmatic hernia. The presence of gas-filled loops of bowel in the pleural space is striking. At times these loops of bowel extend to the dome of the pleural cavity and a rough estimate of the extent of the hernia can be reached. The heart and mediastinum are shifted to the unaffected side. Postero-anterior and lateral x-rays of the chest are sufficient. The ingestion of barium in an attempt to determine the size of the diaphragmatic defect, as well as which organs are displaced, is not only unnecessary but actually hazardous. The one exception in this respect is that of an esophageal hiatus hernia wherein the accurate determination of the length of the esophagus and the size of the opening in the diaphragm are of real importance.

Therapy

To delay definitive surgical treatment is futile since medical measures produce only transient relief.[6,7,8] Surgical procrastination has resulted in the deaths of many infants and children suffering from this disorder.

As soon as a definite diagnosis is reached, surgical intervention is indicated.[9,10] If operation is undertaken within the first few hours following birth, very little distention of the intestines will be encountered, thus facilitating the operative procedure.

If distention is present, gastric aspiration and the use of enemas are indicated. Adequate preoperative hydration is essential. The patient should be typed and cross matched for blood transfusion,

and before operation is undertaken, a cannula is inserted into a leg vein to permit supportive blood and fluid replacement during the course of the operation. Continuous oxygen therapy is often necessary prior to operation in order to minimize the state of cyanosis.

With regard to the anesthetic agent to be employed, ether by use of the open mask has proved satisfactory. It is preferable, however, to utilize a closed system both to provide as high an oxygen percentage as possible as well as to exert positive control of respiration.[11] An intratracheal tube is not necessary; a close-fitting face mask, however, is essential. Cyclopropane anesthesia has been recommended as a desirable agent, particularly in view of the fact that high oxygen concentration is thereby attained. Ether anesthesia, however, is very satisfactory and can be administered by closed system technic. Although the proper administration of an anesthetic agent is of the greatest importance during the course of any surgical procedure, yet the successful anesthetic management of a newborn baby or older infant, suffering from relatively great cardiorespiratory embarrassment, should be entrusted only to the hands of one skilled in the use of anesthetic agents in children. Often apparatus must be improvised to adequately meet the unusual problem to be faced. The successful outcome of the entire procedure is largely dependent upon the resourcefulness of the anesthetist.

Operative Technic

Although some surgeons recommend a combined thoraco-abdominal approach[12] and others prefer a thoracic approach,[13] yet the majority of surgeons dealing with this disorder today advocate a transabdominal approach.[14,15] It should be borne in mind that whereas the transthoracic approach is often highly desirable in the treatment of diaphragmatic hernia in the adult, yet the transabdominal approach is the procedure of choice in infants and children. In the average hernia in the adult, adhesions are present; these can be dealt with most effectively by direct exposure through the chest wall, and subsequently the stomach and intestines can be replaced into the peritoneal cavity with relative ease. However, in a congenital diaphragmatic hernia, adhesions are practically always absent, and so this problem does not present itself. Also, it is well nigh impossible by a transthoracic approach to reduce the viscera residing in the infant's chest into the peritoneal cavity, since the latter is markedly underdeveloped and does not contain space to care for the additional organs. Attempts at transthoracic repair of congenital diaphragmatic hernias by various surgeons have often failed and have resulted in the use of a combined exposure with increased operative risk. In certain instances, however, cited by

Gross, the transthoracic approach is appropriate: (1) in an esophageal hiatus hernia, (2) in a recurrent hernia, and (3) in a hernia into the pericardium. Much has been written with reference to the advisability of preliminary crush of the phrenic nerve. Although preliminary phrenic nerve crush would appear to be a desirable procedure, it has been found unnecessary in most cases. However, it is of value in the repair of relatively large defects.

The abdominal incision may be either subcostal or rectus in type, depending upon the inclination and experience of the surgeon. The rectus muscle splitting type of incision has proved very satisfactory. The first step in correction of the hernia consists in the introduction of a catheter into the pleural cavity, thus allowing air to enter the latter and aiding in equalizing the pressure. This step will facilitate the withdrawal of the herniated viscera. Immediately after withdrawal the viscera are covered with warm saline packs, and are placed outside the peritoneal cavity. The defect in the diaphragm is sutured, using nonabsorbable suture material, and overlapping the edges of the defect unless, by this means, undue tension on the suture line results. It is not necessary to denude the edges of the hernial ring as was formerly thought. If a sac is found, complete excision of the sac is performed with subsequent closure of the defect.

An attempt is then made to reconstruct the abdominal wall in layers. In many instances this will be possible. In other cases, of a more severe nature, it will be immediately apparent that attempted closure of the abdominal wall in layers places a heavy burden upon the respiratory system of the infant. This arises from the fact that the viscera, which had been displaced into the pleural space, are now crowded into a relatively small, underdeveloped peritoneal cavity with resultant marked increased pressure on the diaphragm. The displaced viscera, by virtue of their residence within the pleural cavity prior to birth, have "forfeited their right of domicile."[16] In such cases Ladd and Gross have devised the procedure of undercutting the skin and subcutaneous tissue, making no effort to close the peritoneum or deep fascia. The skin and subcutaneous tissue is then closed over the protruding viscera so that an intentional incisional hernia results. In the course of some five to six days, adequate stretching of the abdominal wall will take place and then a second stage operation can be performed, repairing the incisional hernia by layer closure. Dorsey[17] describes a method of manually stretching the abdominal wall in a 4 year old child on whom he operated for congenital diaphragmatic hernia. By this means he was able to perform a layer closure of the abdominal wall after replacement of the viscera into the peritoneal cavity.

Care following operation is of extreme importance in achieving a successful outcome. An oxygen tent or hood is used since this measure not only diminishes the respiratory effort, thus saving the infant's energy, but also minimizes postoperative distention of the bowel. Occasionally a pleural effusion will occur requiring aspiration. Customarily blood, in an appropriate amount, is administered during the course of the operative procedure or immediately thereafter, taking care to avoid embarrassment of the right side of the heart.

Continuous gastric suction is maintained for a period of 8 to 10 hours following operation, after which the tube may be removed. If further evidence of distention occurs, reinsertion of the tube should be performed without delay and the fluid and gas aspirated. During the initial two to three days following operation, oral intake is gradually increased as tolerated. The type of feeding, of course, is dependent on the age of the patient. It may be necessary to administer parenteral fluid in order to maintain adequate hydration during this interval of time.

Case Report

A. W. P., a white male, birth weight 6 pounds 6½ ounces, was delivered on Mar. 25, 1948, in a midwestern town by a relatively short labor, following an uneventful full-term pregnancy in a 31 year old primapara. Although spontaneous respiration occurred immediately after birth, cyanosis was marked. Dr. R. B. Wray, the attending physician, noted that the abdomen was very small for a full term baby. Ten minutes following birth, respiration became so embarrassed that a resuscitator was required. Later the baby was placed in an incubator with oxygen, but even so cyanosis was observed upon three or four occasions during the first night of life. X-ray of the chest revealed gas-filled loops of bowel occupying the left pleural space. The infant was placed on a formula with a high Karo content in order to promote free stools. Although the formula was taken reasonably well, it was often necessary to interrupt the feedings due to development of cyanosis. No vomiting occurred.

The infant was flown by the United States Air Force to Washington, D. C. Continuous oxygen therapy was used during the flight under the supervision of the baby's physician.

On admission to Walter Reed General Hospital, Army Medical Center, Washington, D. C., on Mar. 31, 1948, physical examination revealed a well developed and well nourished appearing newborn infant of 6 days. Even while the patient was receiving oxygen the respiratory rate ranged from 100 to 112 per minute. Upon removal from the oxygen tent, cyanosis promptly appeared. Examination of the chest revealed diminished excursion of the left side. In addition the left chest was dull to percussion and upon auscultation borborygmi were heard. Breath sounds over the right side of the chest were diminished. Percussion of the heart revealed displacement to the right side.

Roentgenograms of the chest showed the presence of multiple loops of bowel in the left pleural cavity, together with marked displacement of the cardiac

shadow to the right side (fig. 1). Complete blood count, urinalysis, clotting and bleeding times were all within normal limits. The patient was typed and cross matched for blood transfusion. Five per cent glucose in distilled water was used as a continuous drip through a cannula inserted into an ankle vein. Parenteral penicillin and Vitamin K were administered.

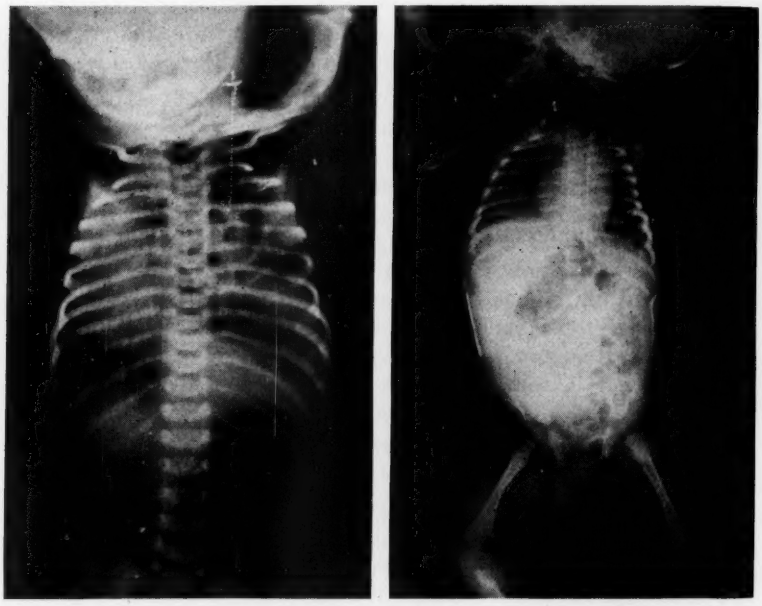

Fig. 1. X-ray of infant immediately after admission to the hospital showing the gas and fluid containing loops of bowel extending to the dome of the left pleural space. Note the marked displacement of the heart to the right side, further decreasing the lung area for respiratory exchange to a critical level. The shadow within the abdomen represents dilated stomach.

Fig. 2. Film taken on the first day after operation. The change from fig. 1 is striking. The heart and mediastinal shadow has returned to normal position. Expansion of both lungs except for a segment of the left upper lobe is evident.

Operation was performed on the same day of admission to the hospital. The patient was inducted with ether by the open drop method. He was then transferred to a closed system, effectively improvised for this 6 day old baby by Lt. Col. John Gardiner, M.C.,[18] oxygen being furnished from a midget Heidbrink machine. Upon opening the abdomen through a left rectus muscle splitting incision, it was immediately apparent that many of the normal viscera were absent. The stomach, duodenum, left colon, liver, gallbladder, pancreas and kidneys could all be palpated within the abdomen. Marked gastric dilatation was relieved at once by passage of a small catheter through the nose into the stomach and suctioning of the air and fluid.

Segments of both small and large bowel were found extending through a 3 cm. wide ovoid defect in the posterolateral segment of the left leaf of the

diaphragm (foramen of Bochdalek). A small rubber catheter was inserted into the left pleural space through this diaphragmatic defect to equalize the pressures, thus facilitating withdrawal of the viscera. Gradual reduction of the herniated structures was performed in the following sequence: the entire small bowel from a point just distal to the ligament of Treitz, the cecum, appendix, ascending and transverse colon, as well as the spleen were all removed from the left pleural cavity. The entire bowel removed was found to be slightly cyanotic, indicating vascular impairment resulting from torsion of the loops. Prompt restoration of color occurred after application of warm saline packs. The left lung had never expanded and the heart was displaced to the right side. There was no evidence of any defect in the right leaf of the diaphragm. Close inspection of the area of the defect revealed that the posterior border consisted in only an imperfectly developed band of muscle fibers forming a narrow rim just superior to the perirenal fascia. Closure of the defect was accomplished utilizing interrupted black silk mattress type of sutures, bringing the anterior edge of the defect down to and incorporating it in the rim of muscle fibers and perirenal fascia as just mentioned, thus effectively closing the opening. Intermittent positive pressure was used by the anesthetist during this procedure. Immediately before the last suture was tied, suction was exerted through a rubber catheter, placed into the pleural cavity, and at the same time the anesthetist expanded the left lung. The catheter was then withdrawn and the last suture tied and reinforced with additional sutures. An effort was then made to approximate the abdominal wound in layers attempting first to close the peritoneum. This attempt, however, caused the baby's respirations to cease. The loops of bowel, tightly fitting into the peritoneal cavity, were then immediately released, brought outside the abdomen and respiration was supported by the anesthetist until the infant's spontaneous respiration resumed shortly. It was apparent that a two stage procedure was indicated.

Accordingly the skin and subcutaneous tissues were undercut on either side of the wound and only the skin and subcutaneous tissues were approximated over the protruding loops of bowel with interrupted black silk sutures. The respiratory rate dropped from 100 to 60 per minute and the infant breathed with greater ease than he had since the time of his arrival at the hospital. Although the infant's color was good immediately after operation, he was placed in an oxygen tent.

A small blood transfusion was given toward the close of the operative procedure. The cannula was maintained in place and additional appropriate amounts of parenteral fluids were supplied for the next 24 hour period. After this time the cannula was removed and the baby was started on small amounts of glucose by mouth, which he tolerated very well. Gastric suction by means of a small Levine tube was practiced on two occasions within the first few hours postoperatively. On the first postoperative day, two spontaneous bowel movements occurred. X-ray of the chest on this same day revealed that both lungs had expanded well except for a small segment of the left upper lobe (fig. 2). In addition the heart and mediastinum had shifted back to normal position. On the third postoperative day the patient was started on a formula of 1½ ounces every three hours by mouth, which he took well.

Marked redness developed about the sites of the skin sutures, due to the unusual degree of tension produced by the underlying loops of bowel. Penicillin, which had been started prior to operation, was continued. It was deemed

advisable to postpone further surgery until clearing of the abnormal process in the abdominal wall and until further expansion of the upper lobe of the left lung.

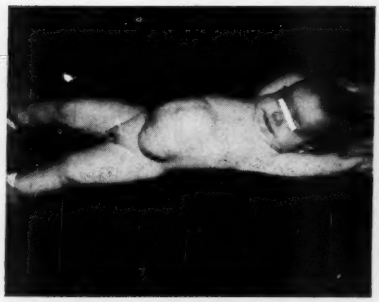

Fig. 3. Front view of the infant three weeks following the first operation. Note the extremely large incisional hernia present. The markedly underdeveloped peritoneal cavity could not accommodate the structures which had formerly resided in the chest. Accordingly these viscera were placed outside the true peritoneal cavity and were covered only with skin and subcutaneous tissue.

Fig. 4. Side view of the infant again showing the very large abdominal hernia.

Patient's postoperative course was otherwise entirely satisfactory. He steadily gained weight and his diet was increased gradually under the direction of the pediatrician. The wound sutures were later removed and close observation for a period of four weeks subsequent to removal of sutures was maintained (figs. 3 and 4). During this period the wound remained intact under

Fig. 5. Front view three weeks after the second operation. The incisional hernia has now been repaired.

Fig. 6. Side view of the baby taken three weeks after repair of the abdominal hernia.

all conditions including the strain of crying. Recovery was so satisfactory that it was thought advisable for the patient to be discharged from the hospital to be readmitted at a later date for second stage hernia repair. It was believed that during this interval further expansion of the left lung would occur and

in addition enlargement of the extremely small peritoneal cavity would take place so that the viscera could be adequately accommodated when an attempt was made to replace them at the second operation.

Accordingly the patient was sent home for a period of three months during which time he was under the close care of his attending physician. Upon readmission to the hospital his general condition was found to be excellent. The incisional hernia wound was well knit and there was no evidence of any inflammatory process. In addition the left lung was now completely expanded.

On Nov. 16, 1948, under open drop ether anesthesia, the patient was operated upon and a repair of the incisional hernia performed. Adhesions present were released and the structures contained in the hernia were replaced into the peritoneal cavity, which now had assumed sufficient size to easily accommodate the viscera. The abdominal wall was then carefully closed in layers. A transfusion was administered during the course of the procedure and the patient was maintained on parenteral fluid for the first postoperative day, following which time intake by mouth was started and gradually increased. His postoperative course was entirely uneventful and he was discharged from the hospital on Dec. 22, 1948, in good condition (figs. 5 and 6). Follow-up 22 months after the second operation reveals that the child is in good condition with no evidence of recurrence of either the diaphragmatic or incisional hernia.

SUMMARY

1. The embryology and pathology of congenital diaphragmatic hernia are reviewed.

2. Clinical manifestations of congenital diaphragmatic hernia are discussed. The great majority of cases show symptoms shortly after birth. Particular emphasis is placed on the positive means of diagnosis afforded by x-ray examination of the chest.

3. Prompt surgical treatment is advocated as outlined, and the fallacy of expectant treatment is emphasized. Early definitive surgical repair has effectively reduced the mortality of this congenital anomaly. Skillful anesthetic management is of the greatest importance.

4. The indication for use of a two stage procedure is discussed. By this means the mortality rate is further reduced.

5. An illustrative case report is presented of a two stage repair of a congenital diaphragmatic hernia occurring in a 6 day old infant.

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PROPHYLACTIC LUMBAR SYMPATHECTOMY IN ARTERIOSCLEROTIC PERIPHERAL VASCULAR DISEASE

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THE encouraging results which have followed the treatment of arteriosclerotic peripheral vascular disease by lumbar sympathectomy are now widely recognized.[1-12] A fatalistic attitude towards the inevitability of the process of aging is no longer justified in this field of surgery since, of the extremities afflicted with symptomatic arteriosclerosis, fully two-thirds can be improved by lumbar sympathectomy. The relief from pain, the increase in ability to walk and work, and the salvage of extremities heretofore doomed to amputation have been dramatic in many cases when lumbar sympathectomy has been employed. The procedure appears fully justified in the more advanced cases of obliterative arteriosclerosis as well, for in a recent report a viable extremity was secured in 78.5 per cent of 28 patients with impending gangrene and in 35 per cent of 83 patients with frank gangrene.[12]

Obliterative arteriosclerosis is not a static process. In a group of 240 patients with symptomatic peripheral arteriosclerosis, Hines and Barker[13] found that 56 per cent developed ulceration or gangrene induced by trauma or injudicious therapeutic measures and, of these, 62 per cent required amputation. Campbell and Harris[14] found in studying a group of 350 patients with this lesion that 220 ultimately developed ulceration or gangrene. Seventy per cent of this group had some form of amputation, 69 per cent of which were supracondylar in type.

The disease is almost invariably a symmetrical one, although symptoms may appear first in one extremity. It has been repeatedly observed that the more pronounced the disability in one extremity the more rapidly do symptoms appear in the opposite member due to the greater strain placed upon it. This is strikingly demonstrated by the arteriosclerotic amputee, who, forced to walk with a crutch or prosthesis, soon develops symptoms in the remaining overburdened leg.

Arteriosclerotic peripheral vascular disease occurs most frequently in the sixth, seventh, and eighth decades, yet, even in the

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aged, sympathectomy has proven to be a relatively benign procedure. In an experience with more than 400 lumbar sympathectomies, not a single operative death has occurred. An accurate preoperative appraisal of the cardiovascular and renal systems and the services of a competent anesthetist are absolute requisites.

In view of the relative innocuousness of lumbar sympathectomy even in the later decades, the decision to utilize it prophylactically has been based on the observation of two types of patients: first, those who were treated by unilateral sympathectomy and returned later with symptoms in the opposite extremity, and second, those patients requiring thigh amputation for arteriosclerotic gangrene who returned because of symptoms in the remaining foot and leg. The following case reports illustrate these two types and furnish clinical evidence in support of the conviction that bilateral lumbar sympathectomy is of value in preventing the early development of manifestation in the asymptomatic arteriosclerotic extremity.

Case Reports*

Case 1. A 50 year old colored male was admitted Jan. 7, 1947, with chief complaint of intermittent claudication of the left leg and foot of three years' duration. Toes felt numb and cold. Foot was pulseless. He had been a known diabetic for 12 years. His walking increased two and a half times after lumbar sympathetic block. On Jan. 21, 1947, a left lumbar sympathectomy was done. The patient was seen on Sept. 11, 1947, and left leg was symptomless but there was severe claudication on right. Patient refused surgery and eventually could not walk sufficiently to leave home. He died, finally, in diabetic coma.

Case 2. A 73 year old colored male was admitted Sept. 16, 1947, with complaint of intermittent claudication of right leg since 1941. A chronic leg ulcer had been present for five years with recent edema of foot and open, weeping lesions. Left leg was negative. On Sept. 13, 1947, a right lumbar sympathectomy was performed with immediate and continued improvement.

Patient was readmitted Feb. 27, 1948, five months later, with severe pain in the left foot developing under clinic observation. The foot was cool with decreased pulsations. The patient was discharged to return for sympathectomy but failed to keep his appointment.

Case 3. A 46 year old colored female diabetic was admitted June 20, 1947, with osteomyelitis of the left fifth toe due to a puncture wound. A decrease in pedal pulsation was present with a cool foot. On Aug. 5, 1947, after long conservative therapy had failed, left lumbar sympathectomy was done. Healing progressed satisfactorily and was complete on Aug. 22, 1947. The right foot was symptomless at this time. She was readmitted one year later with infection and gangrene of the right foot. Hot soaks had been employed to treat a minor infection. A below-the-knee ablation was necessary. The left foot has remained well to the present despite the added strain.

*From the series reported statistically by DeBakey, Creech, and Woodhall.[12]

CASE 4. A 57 year old colored male was admitted on Oct. 20, 1947, with the chief complaint of a constant ache in the left foot for six weeks with intermittent claudication of the left calf for one year. Pain in the foot was present at rest and eased by dependency. The left foot was cool and without pulsations. The foot was shiny with rubor on dependency. The right foot was warm with fair pulsations in the posterior tibial and dorsalis pedis. Left lumbar sympathetic blocks increased walking and relieved pain. On Oct. 28, 1947, a left lumbar sympathectomy was done.

Patient was readmitted with gangrene of the left foot 16½ months after sympathectomy. Low thigh ablation was performed. Pulsations were now absent in the right foot and right lumbar sympathectomy was performed.

COMMENT

These 4 cases demonstrate the relatively early appearance of symptoms in a previously symptom-free extremity. Bilateral sympathectomy initially n ight have forestalled this occurrence.

CASE REPORTS

CASE 1. A 57 year old colored male was readmitted Dec. 1, 1947. On Nov. 10, 1946, this patient had a left thigh amputation for gangrene of the left foot. He had done well on crutches until the summer of 1947, which marked the onset of intermittent claudication of the right calf and coolness of the right foot. At the time of his readmission, gangrene of the first toe was present. The entire foot was red and swollen, and pedal pulsations were absent. On Dec. 9, 1947, a right lumbar sympathectomy was done. This failed to halt the gangrene and a right supracondylar amputation was done on Jan. 3, 1948.

CASE 2. A 70 year old colored male was admitted on Aug. 18, 1949, 10 days after the onset of pain in the right calf and the appearance of blisters on the toes. Pedal pulsations were absent on the right but present on the left; however, intermittent claudication affecting the left calf was present. On June 18, 1949, a right lumbar sympathectomy was performed and on June 22, 1949, the right leg was amputated below the knee. The patient used crutches satisfactorily. Readmission occurred on June 14, 1950, with the history of progressive pain and discoloration of the left fourth toe for 10 days and of the first toe for three days. The first and fourth toes were gangrenous, the foot was covered literally with a bleb, and no pulsation was palpable. On June 15, 1950, left low thigh ablation was performed.

CASE 3. A 67 year old colored male was admitted Mar. 19, 1947. This patient had a right supracondylar amputation in 1943 for arteriosclerotic gangrene. He used a prosthesis and developed a small blister on the left third toe three weeks before admission. There was extension to gangrene of the toe and edema of the foot, with no pedal pulsations. On Mar. 17, 1947, below-the-knee amputation was performed.

CASE 4, A 70 year old white male was admitted May 2, 1949. He had had left thigh ablation in 1945 for arterioscrelotic gangrene and used prosthesis. Ulcers appeared on dorsum of the right first and second toes several months before admission. He had noticed progressive foot pain for two months; there

were no pedal pulsations. On May 16, 1949, below-the-knee ablation was performed.

CASE 5. A 40 year old colored male diabetic was admitted on Dec. 4, 1948. In March, 1947, he had had right supracondylar amputation for diabetic gangrene. One month before present admission, a sore developed on the left big toe. This progressed to obvious gangrene of the foot. There were no pedal pulsations. On Dec. 4, 1948, a left below-the-knee amputation and left lumbar sympathectomy were performed.

CASE 6. A 65 year old colored male, a diabetic with hypertensive cardiovascular disease, was admitted on Mar. 24, 1947. One month before admission, the patient noticed that the left foot was colder than the right. Within a week, throbbing pain appeared in the left first toe and between the fourth and fifth toes. Pain progressed and edema of the toes appeared. He was admitted with a cold, pulseless, edematous, painful foot. Some relief was obtained from lumbar sympathetic blocks. He refused surgery.

He was readmitted May 6, 1947, with frank gangrene of the left foot. Amputation of the left leg and right lumbar sympathectomy were advised. Left low thigh ablation was performed May 8, 1947. Sympathectomy on the right was deferred and he used crutches in the interim.

He was readmitted on Jan. 27, 1949, with intermittent claudication of the right calf, cool foot and absent pedal pulsations. Right lumbar sympathectomy was performed with relief of symptoms.

CASE 7. A 61 year old colored male was admitted Jan. 11, 1946, with complaint of coldness and numbness of the left foot of eight months' duration. The foot was cold and without pedal pulsations. Similar complaints had preceded amputation of the right leg in January, 1944. He used crutches in the interim.

On Jan. 19, 1946, left lumbar sympathectomy was performed and relief of symptoms has persisted until the present time.

CASE 8. A 53 year old colored female was admitted July 24, 1948. She had amputation of the right leg in 1944 for diabetic gangrene. She used crutches. On present admission she had gangrene of the left fifth toe. On July 29, 1948, a left lumbar sympathectomy was done with fair results to the present time.

CASE 9. A 74 year old colored female was admitted Feb. 23, 1949. This patient had had a mid-thigh amputation of the left leg for arteriosclerotic gangrene Feb. 15, 1948. She had used crutches. For the past five months, the right leg had been cold and somewhat numb. Pulsations were present. Right lumbar sympathectomy was performed on Feb. 28, 1949, and the patient was considerably improved.

CASE 10. A 63 year old white male was admitted Mar. 22, 1949. In March, 1943, he had left mid-thigh ablation for arteriosclerotic gangrene. He used prosthesis. In March, 1949, marked onset of intermittent claudication of the right calf and foot was relieved by rest. The foot was cold and pulseless with rubor on dependency. Right lumbar sympathectomy was performed on Mar. 31, 1949, with good results to the present.

CASE 11. A 63 year old white male diabetic was admitted June 11, 1944.

He had amputation of the right thigh for diabetic gangrene Jan. 4, 1944. He used prosthesis. Present admission was due to the toe blisters, persistent pain and infection. On Aug. 29, 1944, left lumbar sympathectomy was done, resulting in improvement.

Comment

These cases (1-5) clearly show the progressiveness of the arteriosclerotic process and indicate the added burden placed on the remaining extremity following thigh amputation. The beneficial effects obtained by sympathectomy on the contralateral side (6-11) afford definite clinical indications for its prophylactic use.

Discussion

Experience with lumbar sympathectomy in the treatment of arteriosclerotic peripheral vascular disease has established it as a rational therapeutic measure. Even in the aged it has proved a safe and effective means of relieving the distressing symptoms, and in a significant percentage of cases has resulted in the salvage of extremities heretofore doomed to amputation.

It has been customary to employ sympathectomy only for the symptomatic extremity, yet in view of the progressive nature and symmetrical occurrence of obliterative arteriosclerosis, bilateral lumbar sympathectomy would appear to be the procedure of choice. Likewise, when amputation for gangrene incident to this disease is necessary, contralateral sympathectomy may delay or halt the appearance of symptoms in the remaining lower limb.

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STUDY OF EXFOLIATED CELLS AS AN ADJUNCT IN DIAGNOSIS

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THE purpose of this presentation is to show how the study of exfoliated cells recovered from the vagina and elsewhere can be of value as an aid in the diagnosis of malignant disease. As you know, considerable enthusiasm for this method has developed since Papanicolaou and Traut[1] published their monograph in 1943. Countless articles in the past few years have shown that it is a reasonably reliable procedure with the advantage of simplicity in collecting and preparing the specimens and at the same time being painless and agreeable to the patient. The chief disadvantage is that considerable time and a great deal of skill is required to interpret the preparation. Also, there may be a tendency on the part of an occasional practitioner to accept a positive or negative report as final without bothering to do a pelvic examination. This is not a disadvantage of the method itself, but I am aware of its having happened a few times. It must be emphasized that this method is primarily an adjunct and not a definitive diagnostic procedure.

The reason for the current enthusiasm for the method, which incidentally has been championed largely by clinicians, is that very early and asymptomatic cancer of the uterus can frequently be diagnosed. Its great usefulness lies in this fact. Obviously, a smear is of no value in a patient with a clinically evident cancer of the cervix and, strangely enough, I have had more false negatives in advanced cervical cancer than in early ones, this because there is so much debris from bleeding, necrosis and infection that the malignant cells are obscured. Asymptomatic cancer will be found occasionally by doing routine vaginal smears as a part of every general physical examination. I would like to discuss the economics involved, but I have been unable to find any agreement on just what the cost of discovering one cancer is.

Smears are also useful in that group of patients who present themselves with very minimal symptoms and whose physical findings are such that one hesitates to recommend biopsy and curettage at once. In this group are those with minor erosions, menopausal women with occasional spotting particularly while taking estrogens, and spotting following inadequate hysterectomy.

One will occasionally be surprised when a positive smear is ob-

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tained from an apparently normal-looking cervix or one with a small innocent-appearing erosion. When such smears are found, all four quadrants of the cervix and the endocervical canal, as well as the fundus, should be biopsied.

We have been doing routine vaginal smears as a part of general physical examinations since March of 1946. In that time, 10 asymptomatic uterine cancers—three in the fundus, six in the cervix and one in the endocervix have been discovered. In addition, there have been 12 patients with minimal symptoms and physical findings who had positive smears which led to immediate biopsy and confirmation of the diagnosis of malignancy. Two of these had negative biopsies the first time and had to be repeated before the diagnosis was established. There were 3 others who had negative biopsies elsewhere from 2 to 11 months previously. Thus, there are 22 women whom we believe were benefited by utilizing smears as an aid to establish an early diagnosis of their disease.

Cytologic studies are also useful in that fairly large group of patients who, for various reasons, are diagnostic problems. If one studies urine sediment, ascitic pleural fluid, sputum and rectal secretions, definite light is often thrown on an obscure condition. Study of sputum, but more particularly bronchial aspiration, will yield a high percentage of positive smears in pulmonary cancer. It is especially helpful in lesions involving the upper lobe where biopsy may fail. The routine study of gastric and prostatic secretion, however, has been disappointing in our hands.

To illustrate how cytologic studies have been of value to us, I have chosen 10 representative cases to present: The first is a cervical cancer from the asymptomatic group. This woman was 38 years of age and came to the clinic because of an allergic condition. Her menstrual periods were quite regular and she denied any intermenstrual bleeding. Routine vaginal smears were made and the surgeon who checked her pelvis stated that the cervix was lacerated and cystic, but was not eroded, and no area was suspicious of malignancy. After the smears were found to be positive, multiple biopsies of the cervix were made and squamous cell carcinoma was found.

The second case is an asymptomatic cancer of the fundus. This 57 year old woman came in for a routine physical examination. She had gone through the menopause two and one-half years before, had noted no bleeding of any kind except for a spot six months previously, none after that. Smears were made as part of the routine check, and they were positive. Cervical biopsies were negative but the endometrial scrapings were positive. This lesion was only a few millimeters in diameter, but nevertheless invasive.

The third case is a 67 year old woman who had minimal symptoms and required biopsy twice before the diagnosis was established. She had noted slight blood-tinged discharge for a few days and on physical examination a cervical polyp 1 cm. in diameter was found. This was removed and biopsy of the cervix at this time showed only metaplasia. Smears were not made. Four months later, there was no bleeding and the cervix looked satisfactory except for an innocent-appearing eroded area on the lower lip measuring 4 by 8 mm. Smears were made this time and they were positive. Biopsy was therefore repeated and a diagnosis of carcinoma of the cervix was established.

The remaining cases to be presented fall in the obscure group.

The first is a 72 year old female who was admitted to the hospital with a complaint of bloody mucus in the stools for two weeks prior to her admission. She also had pain and urgency on defecation. There was a history of hemorrhoids having been treated by suppository. She was in the hospital nine days. During this time she was sigmoidoscoped twice and had two barium enemas. These failed to show any lesion. Smears were made at the time of sigmoidoscopic study and they showed cells which were considered malignant but since the other studies were negative it was felt that they perhaps were coming from a polyp. There was also some question about an amebic infection so she was dismissed from the hospital and followed as an out patient for a period of three weeks. During this time an amebic infection was ruled out and two more barium enemas, including air contrast, failed to reveal any lesion. Smears continued to be positive. Exploratory operation was done and carcinoma of a redundant loop of the lower sigmoid was found.

The next case is a 42 year old female who had had a previous x-ray diagnosis of cholelithiasis. She was having severe right upper abdominal pain and was referred with a diagnosis of acute cholecystitis. Past history revealed that she had had carcinoma of the cervix treated a year previously. On physical examination it was found that she had fluid in her right chest. This fluid was aspirated and it contained cancer cells; the conclusion was that she had pulmonary metastases and, of course, a useless operation was not done. She died four months later of her cancer.

The next patient is a 55 year old woman who entered the hospital with pleural effusion. She had a known tuberculosis of the kidney and the impression of the admitting physician was that she had tubercular effusion. Aspirated pleural fluid showed no cancer cells nor did it show acid fast bacilli. She was bronchoscoped and no lesion was seen, but secretion obtained at bronchoscopy showed cancer cells which were unequivocal.

The next case, also a pulmonary cancer, with x-ray findings of a left upper lobe opacity, was obscured because of an infection by actinomyces. The sputum smears, however, showed that there was an underlying malignancy.

The next case is a 6 year old boy who had not been well for the previous six months. He had had vague abdominal symptoms with a low grade fever. During this time, he had been subected to appendectomy and tonsillectomy and finally kept in bed for three months with a diagnosis of rheumatic fever. The day before he was admitted to the hospital his local physician had noted enlargement of the liver. When examined by us, he did have a very large liver with some abdominal fluid. The spleen could not be palpated and there was no lymph node enlargement. Blood count was nonrevealing; it showed 3,800,000 red cells with 11.5 Gm. hemoglobin; white cells numbered 11,200 with 49 per cent lymphocytes, none of which appeared abnormal. Some of the ascitic fluid was drawn out and a smear made from it. A diagnosis of leukemia was made. The youngster died about a month later. Dr. Wilson of the University of Kansas reviewed the autopsy sections and he thought it should be classified as a monocytic leukemia.

The next case represents a papillary carcinoma of the renal pelvis. Two patients presented themselves at a relatively close interval. Both had painless hematuria; both had filling defects in the pelvis of the kidney and the radiologist felt that renal neoplasms were probably present in both. However, the first showed cancer cells in the urine; the other did not. The fact that cancer cells were not found in one, of course, did not rule out cancer, but we did know we were dealing with malignancy before operation in the other. The second patient had a non-opaque stone in the renal pelvis.

The last 2 patients represent extrauterine cancer with positive vaginal smears. The first was 59 years old and had had a bloody vaginal discharge for one week preceding. She had a normal-looking cervix, but the uterus was quite large and nodular. Vaginal smears were positive. Cervical and endometrial biopsies were negative. Smears continued to be positive and it was felt that she probably had an endometrial carcinoma hidden behind a fibroid. At operation, she was found to have bilateral papillary adenocarcinoma of the ovary, the cells, of course, having come down through the tubes. The other patient, a 68 year old woman, complained of pain in the right side, weight loss and weakness. She had a palpable mass in the right lower quadrant. Vaginal smears were positive. She was found to have a carcinoma of the ascending colon with peritoneal transplants. The genital organs were normal.

In conclusion, I would repeat that the study of exfoliated cells can be a valuable adjunct in the diagnosis of early uterine maligancy but that it is not a definitive diagnostic procedure. It should be given consideration as an integral part of every general physical examination. Valuable information may also be obtained at times in some obscure conditions by cytologic study of urine, sputum, ascitic and pleural fluid and rectal secretions.

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MEASURES TO COMBAT THE MENACE OF CANCER

Because of innumerable scientific advances made in medicine each year the death rate for most diseases is slowly but gradually declining. However, the death rate from cancer, heart disease and a few other diseases continues to climb. According to vital statistics reports, 197,042 people died from malignant diseases in 1948, compared to 189,811 in 1947, and 182,005 in 1946. This increase is, no doubt, correctly ascribed to the increase in population, and to the fact that annual increase in life expectancy is responsible for more people reaching the cancer age.

The vast majority of malignant tumors remain localized for a time before metastasizing, thus making a cure by surgical excision or radiation possible. A great many patients are thus cured, but unfortunately, definitive care is delayed so long in so many patients that curability is impossible. Failure of the patient to go to a physician, and inability of the physician to make the diagnosis are the two major explanations for the high rate of incurability. Accordingly, it can be said truthfully that proper utilization of present knowledge without any new discoveries, in the field of cancer, would save thousands of lives annually; this increased preservation of

lives with proper use of present knowledge would no doubt be greater in cancer than in any other disease under these circumstances of optimum therapy with present methods.

This opportunity of reducing the death rate from cancer must not go unheeded. We must make every effort to get the patient to the physician earlier, and to reduce the delays or errors in diagnosis to a bare minimum. The former can be accomplished by education of the laity in some of the danger signals of cancer, and to the fact that cancer is curable. Some individuals have expressed the fear that a step-up in lay education would create cancerphobia in a great many people. The present author admits that an increased number of people might develop deep concern over trivial manifestations, but it is our contention that with a very few exceptions the physician could rapidly dispel those fears, if no cancer was found after a careful examination. It is probably true that the people with incorrectible cancerphobia are so disturbed emotionally that they would develop a phobia to some other disease or condition if cancerphobia was not available to them. Experience at cancer detection centers corroborate the insignificance of cancerphobia.

The value of cancer detection centers in discovery of malignancy and other significant disease is illustrated by a recent report of the center at the University of Minnesota. In the first two years of its operation, 34 patients with cancer and 776 patients with precancerous lesions were found; of the latter group, 369 were rectal polyps. In addition to these lesions other medical conditions requiring medical attention were found in 2,149 patients. Many physicians are opposed to cancer detection centers on the grounds that they are practicing medicine. However, detection centers do not treat patients, but send those with cancer or other significant diseases back to their physician; thus more patients are being discovered and distributed to individual physicians. Moreover, many of the detection centers discourage or prohibit the patient from returning a second time; the patient is told to report back to his physician. Detection centers are often confused with cancer clinics which are being organized in many hospitals for the purpose of free discussion of patients with malignant disease by various members of the hospital staff; in such groups the physician sends the patient to the clinic, which refers him back to the physician who may carry out the treatment with the benefit of consultation in the clinic.

Although detection centers discover many early cancers, and encourage lay people to watch for early significant symptoms or signs, it would be preferable to have the doctor's office serve as the detection center. This is being done in many areas, as is exemplified

by the report of one rural physician (Siddall in the *Journal of the American Medical Association,* Feb. 3, 1951), who examined 950 presumably well people in a six year period, and discovered 13 malignant growths; in addition, he found 255 benign lesions for which treatment was given or advised.

During the course of a year's time the average physician in general practice sees comparatively few patients with cancer. Seeing a new patient with cancer, only at intervals, makes it necessary that the possibility of cancer be uppermost in the mind of the physician, particularly since the symptoms are so insidious in so many types of cancer. Thorough examination including digital examination of the rectum, proctoscopy and particularly the use of x-ray (with barium) for examination of the stomach and colon will do much indeed to find many early cases of cancer.

Even though the patient with cancer does come to the physician fairly early for treatment, numerous problems in the type of treatment or technic of an operation will present themselves. For example, when should a carcinoma of the pancreas be resected; how often should one perform total gastrectomy for carcinoma? Some of these questions are exceedingly important in the final outcome but a dogmatic answer to them is not always available. It is probably fair to state that resection in carcinoma of the pancreas must not be palliative, but should be limited to lesions when all gross tumor is readily resectable. Perhaps a total gastrectomy should be performed on most occasions when the tumor is located in the upper half of the stomach, but rarely in pyloric lesions since metastasis will take place through the gastrohepatic omentum to the liver before invading the entire length of the stomach in the wall.

New problems will arise from day to day. At the present time the author is deeply concerned over the possibility that we may be negligent in the prevention of the relatively frequent recurrences of tumor at the stoma when anterior resection for carcinoma of the rectum and rectosigmoid is performed. A serious defect in our technic exists. For example, it is well known from examination of rectal secretions in patients with carcinoma of the rectum and sigmoid that cancer cells (presumably alive) are found in the lumen many inches distal to the lesion. Yet when we cut across the lumen of the bowel distal to the lesion we do little or nothing to prevent transplantation of these desquamated cells from the lumen into the cut section of the bowel at the anastomotic site. Seldom indeed does a recurrence develop in the terminal end of a colostomy, even though the bowel is often transected no more than 8 to 10 cm. from the upper edge of the tumor which is removed by the Miles technic

along with all of the distal rectum. Since recurrence is found so rarely in the end of a colostomy proximal to an excised cancer, and since lymphatic drainage is proximally, and rarely travels more than three or four cm. distally from a tumor, there appears to be circumstantial evidence that we may be seeding cells recently desquamated or dislodged by our manipulation, from the tumor, into the cut end of the remaining bowel at the site of the anastomosis. Thorough irrigation of the distal segment of rectum after ligature of the bowel between the tumor and proposed site of anastomosis, along with instillation of certain chemicals are factors which deserve consideration in the prevention of possible seeding from desquamated cells. A study of these factors is being made in our clinic at the present time.

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BOOK REVIEWS

The Editors of THE AMERICAN SURGEON *will at all times welcome new books in the field of surgery and will acknowledge their receipt in these pages. The editors do not, however, agree to review all books that have been submitted without solicitation.*

A TEXTBOOK OF MEDICINE. Edited by RUSSELL L. CECIL, M.D., Sc.D., Professor of Clinical Medicine Emeritus, Cornell University, New York, and ROBERT F. LOEB, M.D., Bard Professor of Medicine, Columbia University, New York. Philadelphia and London, W. B. Saunders Co., Publisher, ed. 8, 1951. 1627 pages. Cloth, $12.00.

It is with pleasure that we note a new edition of that old friend and standby of so many medical students, interns and practitioners. The present volume is an improved and expanded edition in which there are 20 new articles; that is, 20 subjects that prior to this have not been included. Here in a single volume is an authoritative discussion of those diseases which comprise Internal Medicine. This makes it an ideal volume for the purpose of introducing the medical students to internal medicine; it likewise makes a fine, quick reference volume for the general practitioner as well as for the busy surgeon. It must always be remembered that before anyone can be a good surgeon he must be a good internist.

This volume, as were the past editions, is written in a scholarly, easily readable manner, and it is indeed a worthy successor to earlier editions, and will find its place as a replacement for those older volumes which are still in daily use.

A. H. LETTON, M.D.

LUMBAR PUNCTURE AND SPINAL ANALGESIA. By R. R. MACINTOSH, M.A., D.M., F.R.C.S. (Edin.), D.A., Nuffield Professor of Anesthetics, University of Oxford; Civilian Consultant in Anesthetics, Royal Air Force; Examiner for the D.A.; Anesthetist, United Oxford Hospitals; Fellow of the Faculty and Anesthetist of Royal College of Surgeons. Baltimore, Md., Williams and Wilkins Co. 149 pages. Cloth, $4.50.

Here is an easily readable volume of less than 150 pages that deals with the history, development, technic and pitfalls of spinal analgesia. The writing is straightforward, simple yet surprisingly in detail. The drawings are of the etched type, but occasionally there is one in illustrative colors in order to convey or emphasize some detail. There is an occasional photograph which is quite clear.

An explanation is given for the occurrence of "dry taps" as well as other difficulties; this is followed by suggestions for their prevention. The illustrations are used very effectively to demonstrate the proper technic as well as the difficulties which may be encountered. A full, easily understandable, nicely illustrated explanation is given of the use of various spinal analgesic agents, viz. the heavy and light solutions as well as the isotonic. It is noted that peculiarly enough the author has not included the dosage of the various agents in this discussion.

This is a useful volume to the surgeon whether he is his own anesthetist or whether he has the benefit of an expert anesthesiologist, for he needs badly to understand spinal anesthesia. The volume should aslo be available to the intern and resident staff of all surgical services.

A. H. LETTON, M.D.

ABSTRACTS FROM CURRENT LITERATURE

STAINLESS STEEL CRANIOPLASTY. Michael Scott and H. T. Wycis. *Journal of the International College of Surgeons 15*:161-171 (Feb.) 1950.

In 1946, Scott and Wycis reported the experimental use of stainless steel plates in the repair of skull defects in dogs. Now they are reporting their experience in the clinical use of this technic in 22 cranioplasties in human beings. The clinical use of this material is prompted by its economy. The cost of an average sized stainless steel plate procured from a recognized dealer in stainless steel and prepared according to the authors' technic is about 10 cents as compared with approximately 30 dollars for a tantalum plate of similar size.

It is emphasized that "18-8 Mo (1.75-2.50) stainless steel" be used. This contains approximately 16 to 18 per cent chromium, 10 to 14 per cent nickel and is fortified with molybdium. (This is the same alloy originally recommended by Babcock for use as suture material.) The authors buy the material in large sheets of the 0.015 thickness.

The technic employed by Scott and Wycis calls for fashioning the plate at the operating table. After the skull defect is exposed and the dura freed from the edge, a pattern of the defect is cut from some material such as polyethylene film and, using double action shears, the plate is cut to size from the pattern. Convexity is obtained by shaping with a mallet on a concave block. The plate is then appropriately perforated. After beveling the edge of the cranial defect and drilling holes for purpose of anchoring the plate, it is fixed in position with stainless steel wire sutures.

Of the 22 patients subjected to stainless steel cranioplasty, one was lost to follow-up. The plate was removed in two instances because of infection and sinus formation. In one patient, a persistent effusion is present over the plate. The result in the remaining 18 instances was entirely satisfactory.

The authors conclude that stainless steel is a satisfactory material for cranioplasty and its economy renders the use of tantalum extravagant. In consideration of these facts, they recommend that the employment of tantalum be abandoned. R. H. S.

INGUINAL HERNIAS: WHY DO THEY RECUR? A. R. Koontz. *Southern Medical Journal 44:* 244-249 (March) 1951).

In reviewing this widely discussed subject, Koontz discusses predisposing factors under the following outline:

1. *Proper method of handling the sac.* Though the accepted high, transfixed ligation of the sac in indirect hernia is generally employed, the technic of opening the abdomen through a muscle splitting extension of the internal ring (originally described by La Roque) must not be neglected as a useful method in treatment of the sac in sliding hernia. The author advocates opening the sac in large indirect hernia with resection of the redundant portion of the sac. In small direct hernias, it is simply pushed in.

2. Among matters of *fundamental technical error* predisposing to recurrence, Koontz emphasizes that failure of removal of areolar tissue from structures used in the repair prevents strong healing. He advocates use of the relaxing incision in the rectus sheath to prevent tension at the suture line. The superiority of nonabsorbable suture material is pointed out. He, as

usual, recommends the use of tantalum mash implants rather than fascial grafts in the treatment of cases with large defects and poor tissues.

3. *Sliding hernia.* La Roque's approach is advocated for dealing with these cases.

4. *Bilateral operation* should not and does not carry a higher risk of recurrence in the author's opinion provided good technical surgery is done and use is made of the fascial relaxing incisions.

5. In regard to the *handling of the testicle* in recurrent hernia, Koontz prefers segmental resection of the cord to orchidectomy since atrophy of the testicle does not always follow resection of the cord.

6. *Postoperative care.* Stressing the importance of avoiding coughing and straining, the usual precautions are outlined. Early ambulation is advocated. According to the author, dressings should be tightly strapped on with wide adhesive extending across the abdomen. This, he feels, lends some support to the suture line in event of inadvertent straining. "A great many anesthetists at the end of an operation, with the patient almost awake, start to suck out the air passages and thereby induce violent straining and coughing. Nothing could be worse for a freshly made suture line . . . When I finish an operation and find the patient is almost awake, I have the morphia given before the patient returns to his room. Once the patient is out from under the influence of the anesthetic, pain will keep him from straining enough to injure his suture line."

"Successful hernia repair is the result of infinite pains and close attention to every detail of the operation, as well as postoperative care."

R. H. S.

RADIOACTIVE DIIODOFLUORESCEIN IN DIAGNOSIS AND LOCALIZATION OF CENTRAL NERVOUS SYSTEM TUMORS. Loyal Davis, John Martin, Moses Ashkenazy, G. V. LeRoy, and Theodore Fields. *Journal of the American Medical Association 144*:1424-1432 (Dec. 23) 1950.

In 200 patients suspected of having central nervous system tumors, studied by means of radioactive diiodofluorescein, the results reveal a 95.5 per cent accuracy in diagnosis in lesions verified by surgical intervention or corroborated by pneumography or angiography. The technic is simple, and instrumentation consists of a Geiger-Mueller tube, a counting rate meter and mechanical graphic recorder. There was a 91 per cent accuracy in the 95 histologically verified space-occupying lesions of the central nervous system, which included 40 gliomas, 13 meningiomas, 13 mestastatic carcinomas and sarcomas, 7 pituitary tumors, 6 spinal cord tumors, 2 cerebellar hemangioblastomas, 1 acoustic neurinoma, 1 melanoblastoma, 3 unclassified tumors, 4 subdural hematomas, 1 porencephalic cyst, 2 cerebral abscesses, 1 arteriovenous fistula and 1 granulomatous cyst.

Localization by the radiodye method proved to be much more precise than with electroencephalography or pneumography, whenever verification was obtained at surgery or autopsy. Pneumography was 63 per cent focally accurate, and electroencephalography was only 45 per cent focally accurate.

The authors believe that the radioactive diiodofluorescein tracer test is a simple, safe, painless and reliable method for localization and diagnosis of

brain tumors, and one which should grow in value as increasingly more sensitive detection equipment and more specific radiodyes become available.

R. F. M.

TECHNIC OF VAGOTOMY AND GASTROENTEROSTOMY IN THE TREATMENT OF DUODENAL ULCER. George Crile, Jr. *Surgery, Gynecology and Obstetrics* *92*:309-313 (March) 1951.

"Experience has shown that gastroenterostomy alone is unsatisfactory treatment for duodenal ulcer and that vagotomy alone is also unsatisfactory. Only about 50 per cent of patients subjected to gastroenterostomy alone obtain satisfactory results, and evidence of recurrent ulcerations occurs in about 11 per cent of patients subjected to vagotomy alone. But each of these operations play a part in controlling duodenal ulcer and in our four years' experience, the two operations, when combined, act synergistically to give better results than can be obtained by gastric resection or any other form of surgical treatment . . . With the combination of a satisfactory vagotomy and a well functioning gastroenterostomy, retention after operation is rarely observed. . . The longer term results appear to be equally gratifying and in our experience have been superior to those following gastric resection both in respect to control of the ulcer and in side effects."

Crile realizes that many surgeons have not been gratified either with the immediate or later results following vagotomy combined with gastroenterostomy for the treatment of duodenal ulcer. He believes this to be due to a difference in the manner of selection of the patients in which the method is employed pointing out that if the method is reserved for the cases with minimal evidence of ulcer, a large percentage of patients with functional disturbances will be included and poor results in these patients will lower the procedure in the surgeon's estimation. Feeling that some of the discrepancy in the results obtained by different surgeons employing the method may be due to differences in technic, Crile sets forth in detailed discussion the technic employed at the Crile Clinic. This, in brief, is as follows:

Through a midline incision following exploration, downward traction is made upon the stomach causing the inelastic vagi to be palpable. (Crile considers visual dissection of the esophagus at the hiatus dangerous and undesirable.) The vagi are located and stripped by palpation. This technic will reveal only the branches of the vagus extending into the stomach but since denervation of the stomach is the object, this is considered to be adequate. The vagotomy is always done first while the field is clean and never following gastroenterostomy. The gastroenterostomy is made at the most dependent part of the stomach which is usually near the pylorus and is made as close to the greater curvature as possible. The anastomosis is posterior and is antiperistaltic, a segment of jejunum about 6 inches from the ligament of Trietz being utilized.

In the last 80 consecutive cases, only 3 suffered gastric retention of a degree sufficient to prolong hospitalization beyond 10 days or to require readmission. In 2 of these, a cause for the retention unrelated to the vagotomy was determined.

The author concludes that a properly functioning gastroenterostomy and an adequate vagotomy, when combined, act synergistically to afford the safest and most effective surgical treatment for patients with complicated duodenal ulcer.

R. H. S.

INGUINAL HERNIA: A NEW SURGICAL TREATMENT. Andre Heffez. *Journal of the International College of Surgeons 15*:38-43 (Jan.) 1950.

Heffez advances a method of repair for inguinal hernia featuring the "elimination" of the inguinal canal. This is effected by division of the inguinal ligament, transplant of the cord beneath the ligament and repair of the ligament with two silk sutures. The "conjoined tendon" is then fixed to the inguinal ligament forming a solid abdominal wall.

The author has employed the method in his most difficult cases and though, admittedly, insufficient observation disallows conclusive statistics, he highly recommends it as being advantageous to the patient and the surgeon. He feels that the procedure decreases, rather than increases, the likelihood of crural herniation since, by laying down the cord in the crural space, he is "only making up for that anatomic dehiscence which predisposes normally to femoral hernia and the elimination of which is a safeguard against recurrence." R. H. S.

IMPENDING DEATH UNDER ANESTHESIA. Max Thorek. *Journal of the International College of Surgeons 15*:152-160 (Feb.) 1951.

Until recently, it was believed that if heart action was not restored almost instantly following sudden cessation of heart action during anesthesia, irreversible damage to the higher centers would occur. In this presentation, Thorek emphasizes that these consequences are not inevitable and that they do not necessarily follow cardiac arrest of much longer duration than the three or four minutes formerly considered to be the maximum compatible with survival.

Shiff first experimented with massage for cardiac resuscitation in 1874. In 1889 Niehaus attempted resuscitation in the human being but was unsuccessful. Maaj in 1900 was able to establish pulsations and respiration which lasted 12 hours. Inbesbrid succeeded in resuscitating the heart in 1901 but failed to report it promptly and in 1902 the first report of a successful resuscitation was made by Starling and Lane.

The author points out the necessity for immediate diagnosis and the necessity of differentiation between the white asphyxia of cardiac arrest and the blue asphyxia of respiratory arrest or obstruction. The absolute necessity of immediate decision is obvious and delay in diagnosis is the chief cause of failure.

When the diagnosis of cardiac arrest is made, massage must be begun immediately. In such emergency, Thorek considers a calm attitude, clean hands and a keen knife to be the most important paraphernalia. The heart may be reached by three routes: (1) transperitoneal subdiaphragmatic, (2) transperitoneal transdiaphragmatic, and (3) transthoracic. If the latter is to be used, the incision should be quickly made in the fourth left interspace from the sternum to the posterior axillary line. There will be no bleeding. The hand is inserted between the ribs and the heart palpated. If action has ceased, it will be soft and flabby. If there is ventricular fibrillation, it will feel like a sack of worms.

The author prefers the standard method of massage and enters the upper abdomen in the midline and massages the heart through the diaphragm. For about 30 seconds the movements are made quick and strong. A single contraction should not be mistaken for victory. If success is not prompt, the pericardial sac is entered through the diaphragm and the massage continued.

Twenty to 60 compressions per minute have been recommended. Artificial respiration with pure oxygen is carried on simultaneously.

The views of various other authors are presented in regard to the use of epinephrine and procaine. Thorek prefers intravenous administration of procaine and is doubtful of the advisability of direct application to the pericardium in case of fibrillation.

Following a short discussion of some other complications of anesthesia, the author presents the case report of a 23 year old woman who was successfully resuscitated after 19 minutes of asystole. The arrest occurred following the administration of pentothal to supplement a spinal anesthesia. The operation (elective appendectomy) was carried out after contractions had been reestablished. The patient was comatose for several days and recovery was very slow but apparently almost complete. She later became pregnant and delivered a normal child.

In discussion, it is pointed out that reflex action through the pathway from the pericardium via the phrenic nerve to the superior cervical ganglion may be an important factor in initiating contractions and the act of opening the pericardium may have been responsible for the success in this and other instances. R. H. S.

PERFORATION OF THE GALLBLADDER. A. G. Fletcher, Jr., and I. S. Ravdin. *American Journal of Surgery 81:*178-185 (Feb.) 1951.

Perforation of the gallbladder is not a common occurrence, but it is well to remember that at least 5 to 10 per cent of cases of acute cholecystitis will progress to gangrene and perforation if operation is unduly delayed. Reported mortality rates in perforation vary widely. Reports in which cases are divided into Types I (free perforation), II (pericholecystic abscess) and III (cholecystoenteric fistula), are of more significance. A review of the reports of five authors who so classified their cases revealed the mortality rate to be 35.8 per cent for Type I, 8.7 per cent for Type II, and 42.4 per cent for Type III. The very high figure for the latter group is largely due to the reports of one group.

The authors report herewith 44 cases of perforation of the gallbladder encountered in a 15 year period at the Hospital of the University of Pennsylvania. These were encountered among a total of 2,807 operations for acute and chronic cholecystitis. In this series of perforations, the mortality rate was 40 per cent for Type I, 4 per cent for Type II and zero for Type III.

Type I of acute, free perforation of the gallbladder is a rare occurrence, more common in male patients having no previous history of gallbladder disease. Physical signs may be deceptively mild. Operation must be prompt and in this group, the operation of choice is peritoneal aspiration followed by cholecytostomy.

Type II, or localized pericholecystic abscess is the most common form. The usual operative procedure is drainage of the abscess and cholecystostomy. Cholecystectomy is sometimes feasible. The postoperative course is smooth and the mortality is low.

Chronic perforation of the gallbladder with formation of a cholecystoenteric fistula is an uncommon end stage of chronic cholecystitis occuring chiefly in elderly females. About one third of the patients are admitted with gallstone

ileus. In the others, the fistula is found at operation for chronic cholecystitis of many years' duration. In the first group, recovery is rapid following simple ileotomy and removal of the stone. In the latter group, the authors have obtained excellent results with cholecystectomy, closure of the fistula and choledochostomy if indicated.

"The incidence and mortality of perforation of the gallbladder can be reduced somewhat by a general policy of early operation for acute cholecystitis and perhaps even more by the practice of elective cholecystectomy for all patients presenting the history and findings of chronic cholecystitis. If cholecystostomy is done during an acute episode, it should be followed with cholecystectomy a few months later." R. H. S.

MEETING OF INTERNATIONAL COLLEGE OF SURGEONS (UNITED STATES CHAPTER)

The Sixteenth Annual Assembly of the United States Chapter of the International College of Surgeons will be held in Chicago on September 10th through the 13th, 1951, with headquarters at the Palmer House.

An excellent program has been arranged. Prominent surgeons from the United States and other countries will participate. Scientific sessions will be held by all specialty sections of the United States Chapter.

The annual banquet will take place on Wednesday evening, September 12. Mr. Lawrence Abel, F.R.C.S. (Eng.), of London, will be the principal speaker.

The Assembly will conclude with the Convocation, to be held in the Civic Opera House on the evening of September 13. Senator Estes Kefauver will deliver an address on "The America of Tomorrow."

Hotel reservations may be arranged by writing to the Housing Division, Chicago Convention Bureau, 33 North LaSalle Street, Chicago 2, Illinois.